BETON-COIGNET:

DESCRIPTION OF THE MATERIAL AND ITS USES,

IN

FRANCE AND AMERICA,

WITH

REPORTS OF DISTINGUISHED ENGINEERS AND ARCHITECTS.

PUBLISHED BY

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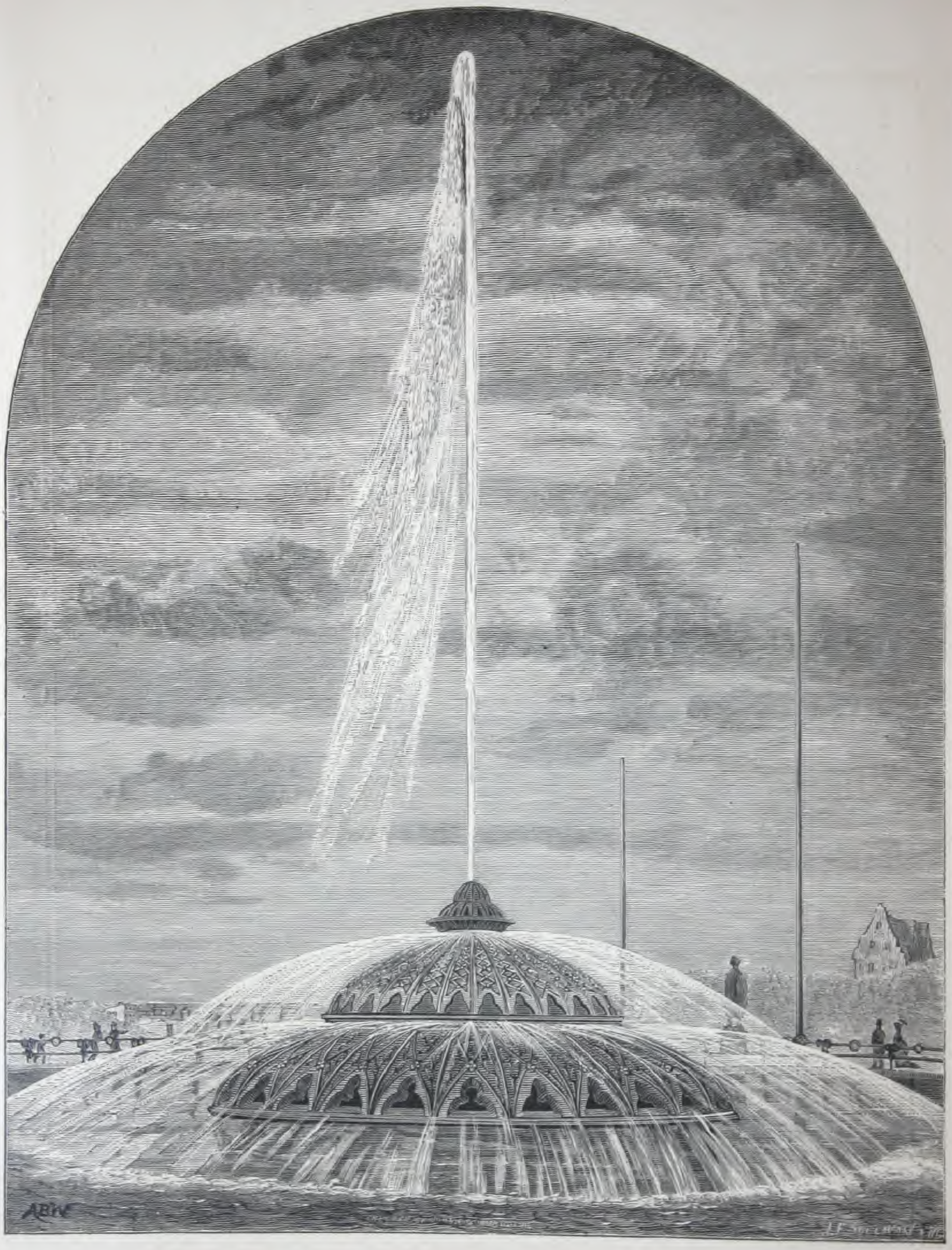

Plaza Fountain, Prospect Park, Brooklyn. Built of Beton-Coignet, 1873.

BETON-COIGNET.

EXTRACT FROM A REPORT ON BETON-COIGNET.

Professional Papers, Corps of Engineers, U. S. A., No. 19.

BY Q. A. GILLMORE,

Major Corps of Engineers, Brevet Major-General U. S. A.

3. This name is given to a béton of very superior quality, or, more properly speaking, an artificial stone of great strength and hardness, which has resulted from the experiments and researches, extending through many years, of M. François Coignet, of Paris.

96. The use of béton aggloméré in France dates back to the year 1856, and confidence in its value has been constantly on the increase since that date.

57. USES OF BETON AGGLOMERE IN EUROPE AND ELSEWHERE.—The most important and costly work that has yet been undertaken in this material, is a section, thirty-seven miles in length, of the Vanne aqueduct, for supplying water to the city of Paris.

This aqueduct, which traverses the forest of Fontainebleau through its entire length, comprises two and a half to three miles of arches, some of them as much as fifty feet in height, and eleven miles of tunnels, nearly all constructed of the material excavated, the impalpable sand of marine formation known under the generic name of Fontainebleau sand. It includes, also, eight or ten bridges of large span (seventy-five to one hundred and twenty-five feet), for the bridging of rivers, canals, and highways.

The smaller arches are half circles, and are generally of a uniform span of $39\frac{37}{100}$, with a thickness at the crown of $15\frac{3}{4}$ inches. Their construction was carried on without interruption through the winter of 1868–9 and the following summer, and the character of the work was not affected by either extreme of temperature. The spandrels are carried up in open work to the level of the crown, and upon the arcade thus prepared the aqueduct pipe is moulded in the same material, the whole becoming firmly knit together into a perfect monolith. The pipe is circular, $6\frac{1}{2}$ feet in interior diameter, with a thickness of 9 inches at the top, and 12 inches at the sides, at the water surface. The construction of the arches is carried on about two weeks in advance of work on the pipe, and the centres are struck about a week later.

Water was let into a portion of this pipe in the spring of 1869, and M. Belgrand, inspector general of bridges and highways, and director of drainage and sewers of the city of Paris, certified that "*the impermeability appeared complete.*"

58. Another interesting application of this material has been made in the construction, completed, or very nearly so, of the light-house at Port Said, Egypt. It will be 180 feet high, without joints, and resting upon a monolithic block of béton, containing nearly 400 cubic yards. In design it is an exact copy of the Baleines light-house, executed after the plans and under the orders of M. Léonce-Regnaud, engineer-in-chief.

59. An entire Gothic church, with its foundations, walls and steeple, in a single piece, has been built of this material at Vésinet, near Paris. The steeple is 130 feet high, and shows no cracks or other evidences of weakness.

M. Pallu, the founder, certifies that "during the two years consumed by M. Coignet in the building of this church, the béton aggloméré, in all its stages, was exposed to rain and frost, and that it has perfectly resisted all variations of temperature."

The entire floor of the church is paved with the same material in a variety of beautiful designs, and with an agreeable contrast of colors.

60. In constructing the municipal barracks of Notre Dame, Paris, the arched ceilings of the cellars were made of this béton, each arch being a single mass. The spans varied from 22 to 25 feet, the rise, in all cases, being one-tenth the span, and the thickness at the crown 8.66 inches. In the same building the arched ceilings of the three stories of galleries, one above the other, facing the interior, and all the subterranean drainage, comprising nearly 600 yards of sewers, are also monoliths of béton.

One of these vault arches, having a span of 17½ feet, was subjected to three severe trial tests, viz:

First. A pyramid of stone-work weighing 36 tons of 2,000 lbs. each, was placed on the centre of the vault.

Second. A mass of sand, 13 feet thick, was spread over the surface of the same vault.

Third. Carts loaded with heavy materials were driven over it.

In no instance was the slightest effect produced.

61. A portion of the basement work of the Paris Exposition building comprised a system of groined arches, supported by columns about 13¾ inches square and 10 feet apart. The arches, having a uniform rise of one-tenth the span, and a thickness at the crown of 5½ inches, are monoliths of béton aggloméré. A system of flat cylindrical arches, of 10 feet span, covers the ventilating passages. They have a rise of one-tenth, and a thickness at the crown of not quite 8 inches, and were tested with a distributed weight of 3,300 lbs. to the superficial yard.

There was consumed in the construction of this basement-work more than 353,000 cubic feet of béton.

Béton-coignet becomes in process of time as impervious to water as many of the compact natural stones, while its matured strength exceeds that of the best qualities of sandstone, some of the granites, and many of the limestones and marbles.

Chemical tests have shown this béton to be practically impervious to water. Two small specimens, each weighing about 2½ grammes, were tried by Dr. Isidor Walz, chemist, of New York City. Their specific gravity was 2.305. They were immersed in water fifteen minutes, and then kept four days in air, saturated with moisture. One of the specimens did not increase in weight at all during the interval, while the other absorbed 16-100 of one per cent. of moisture.

This material, therefore, possesses all the characteristic properties of durability, being dense, hard, strong, and homogeneous; and there would appear to be no reason for supposing that it may not, with entire safety, be applied to out-door constructions, even in the most northerly portions of the United States.

It is injured by freezing before it has had time to set. Important works should not, therefore, be executed during the winter in cold climates.

The effect of freezing on newly made béton is to detach a thin scale from the exposed surface, producing a rough and unsightly appearance; but the injury does not extend into the mass of the material, unless the frost be very intense.

In monolithic constructions, the plank coffre affords sufficient protection to the face surfaces of the work against moderate frost, and, when the temperature ranges generally not much lower than the freezing point during the day, work may be safely carried on, if care be taken to cover over the new material at night. After it has once set, and has had a few hours to harden, neither severe frost, nor alternate freezing and thawing, has any perceptible effect upon it, and, under any and all circumstances, it is much less liable to injury from these causes, and requires fewer precautions for its protection against them, than common hydraulic concrete.

The Vanne Aqueduct. Built of Beton-Coignet, 1868.

Monolithic constructions in béton aggloméré may advantageously be carried on whenever it is not too cold to lay first-class brick masonry.

In Paris and vicinity operations are not generally suspended during the winter, unless the cold be unusually severe for that climate.

Pieces of statuary, and other specimens ornamented with delicate tracery, have been exposed for five consecutive winters to the weather in New York City without undergoing the slightest perceptible change.

62. Over thirty-one miles of the Paris sewers had been laid in this material prior to June, 1869, at a saving of 20 per cent. on their lowest estimated cost in any other kind of masonry.

63. Several large city houses, some for places of residence, and others for business purposes, have been constructed, and many others are in contemplation. In these the entire masonry, comprising both the exterior and the partition walls, the chimneys with flues, cellar arches, cistern, &c., is a single monolith of béton aggloméré.

In one house, having a cellar below the street level, and six full stories, surmounted with a Mansard roof above, the thickness of the exterior wall was established as follows, viz.: cellar, 19.7 inches; first story, 15.7 inches; second story, 13.8 inches; third story, 12.8 inches; fourth story, 11.8 inches; fifth story, 10.8 inches; sixth story, 9.8 inches.

The cellars of such houses are usually divided into two large compartments by a wall parallel to the street, and these are covered by a flat arch of béton, the usual proportions of which are a rise of one-tenth the span, a thickness at the crown of 5¼ to 5½ inches, and a thickness at the springing line of 8¼ to 9 inches.

Spaces not exceeding thirteen or fourteen feet in width may be spanned by flat platforms from ten to twelve inches thick, and, similarly, the pavements of sidewalks may be in one continuous piece of béton, with street vaults below.

64. An interesting application of this material in the construction of a hollow sustaining wall was made at the cemetery of Passy, in supporting a bank of earth 29½ feet in height. In that wall the volume of the hollows is equal to 53 per cent. of the aggregate volume of béton. The hollows were filled with dry earth.

65. The jetties at the entrance of the Suez Canal are built of béton-coignet. The construction is not monolithic, the béton having been formed into blocks, weighing about twenty tons each on land, where they were allowed to harden for two or three months before they were used. The jetties are twenty-six yards wide at the base and six yards wide at the summit, and are twelve yards in height. About sixteen thousand blocks have thus far been used in their construction, and but little remains to be done toward their completion.

66. All the works above referred to, except those at Port Said, were visited by the writer in the month of February, 1870, and these statements are based upon close observation and personal knowledge.

Many other interesting applications of this material were examined, of which it is not deemed necessary to make any special mention, except that in combined stability, strength, beauty, and cheapness, they far surpass the best results that could have been achieved by the use of any other materials, whether stone, brick, or wood.

Carefully laid on a roof surface over arches, it is claimed that the usual bituminous covering may be dispensed with.

In the numerous and varied applications which have been made of it in France, it has received the most emphatic commendations from the government engineers and architects.

Monolithic buildings in béton, with arched ceilings in all the rooms, are practically fireproof.

68. Foundations, generally, both in and out of water; for the piers, arches, and roof surfaces of casements; for parade and breast-height walls, &c., &c.

67. For warehouses, churches, and large buildings of every description; for foundations, quay-walls, light-houses, jetties and piers; for abutments and massive walls of all kinds; for

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sidewalks, platforms, and flagging, and for many other minor purposes, béton aggloméré possesses not only great comparative cheapness, but all the essential merits of brick and stone with respect to strength, hardness, and durability; while for many purposes, such as cellars and cellar floors, cisterns, reservoirs, tanks, and fountains, arches, vaulted ceilings, and vaults, tunnels, aqueducts, sewer and water pipes, and ornamental work of every description within the province of the architect or engineer, it possesses advantages peculiar to itself, and not equally shared by other materials.

Extracts from a Report made by Francois Coignet, to the Civil Engineer of Paris, March 19th, 1869:

"GENTLEMEN—You have already on several occasions received with favor the communications which I have made to you in reference to the uses and applications of the agglomerate invented by me.

"I shall dwell no longer upon this point (the mode of preparation), which to-day is perfectly demonstrated. I shall not refer to the works already accomplished, and to which I have called your attention in my preceding communications, such as the saw-mill of Mr. Hinguerlot; the church of Vésinet; the sustaining wall of the Boulevard de l'Empereur; the works of the Exposition, and the twenty-five to thirty miles of sewers in the city of Paris. I only desire to call your attention to the new uses to which it has been applied within two years.

"In the first place, I will mention the eight or ten large buildings which we have constructed in Paris. They are five and six stories high, are built exclusively of agglomerate from top to bottom, and it has proved practical to reduce the thickness of the walls to a remarkable extent. The *façades* of these buildings are ornamented, and though several of them were built in mid-winter, their resistance to frost is absolute, even in those the roofs of which are terraced in this material. Its use, then, for the construction of houses, is an accomplished fact, and in the perfection attained our hopes have been more than realized.

"I would further bring to your notice its application to a purpose which, though more limited, is not without its importance—that is, to the construction of foundations, vaults, and the underground portions of buildings of any size. In regard to this there can be no two opinions, and the most eminent engineers and architects who have examined the foundations that we have constructed are unanimous in their praise. For this class of work the material is perfection itself—strength under every trial, the absence of joints and consequent freedom from all infiltration, beauty of form, smoothness of surface, although without plastering, reduction of bulk, economy in expense, and unexampled boldness of arches—all these qualities are here found combined.

"I can cite, as the most perfect type of this special application, the foundations of our house in the Rue Miroménil, and particularly those of the out-houses of the mansion of Mr. E. André, on the Boulevard Haussmann, the vaults of which are so extensive, with such a reduced thickness of wall, and with such flat arches of so great a span, that it is safe to say it would be impossible to construct similar work out of the materials usually employed, and in this opinion we are sustained by the most competent architects. I would likewise call your attention to the sustaining wall of the cemetery of Passy, which is truly monumental, as well as to the great collecting sewer which leads from Paris to La Briche, and which has cost a million and a half of francs. This sewer has been built under difficulties of every kind—among them, especially, a succession of inundations; for, through a great part of its length, it ran alongside an old sewer in bad repair, which constantly discharged its waters into the deepest cuttings.

"This sewer included a tunnel, which it was necessary for us to construct in order to pass under the track of the Railway du Nord, and we succeeded perfectly, in spite of the jarring of the trains, and of five successive inundations of the river Seine.

"This sewer, finished a year and a half ago, is a monolithic tube, without joints; its hardness and its homogeneity are all that could be desired, and notwithstanding all the great difficulties above mentioned, it is without a single crack, and shows no evidence of weakness.

"But of all the works which we have undertaken, the most important is, beyond dispute, the construction of the Aqueduct of Vanne, from the River Yonne to the borders of Esconne at Chevannes, about thirty-seven miles in length, which is to cost eight millions of francs.

"This aqueduct, which traverses the Forest of Fontainebleau through its whole length, comprises two and one half to three miles of arches, some of them as much as fifty feet in height, and eleven miles of tunnels, nearly all constructed of the material excavated, the impalpable sand of marine formation known under the generic name of Fontainebleau sand. It includes, also, eight or ten bridges of large span (seventy-five to ninety feet), for the bridging of rivers, canals, and roads. This work was commenced about the middle of the year 1868, and is to be completed in three years. Already, in eight months, one-third of the work is finished. Several miles of arches are built. These arches are forty feet span, are fifteen and three-quarter inches in thickness at the crown, and in some instances they are fifty feet in height. They have been constructed without interruption through the heat of summer and the frosts of winter, and they have been entirely unaffected by either extreme of temperature. Built in ordinary masonry, similar arches ought not to have had over twenty feet span; with a span of forty feet they would be really wonderful; but they are all the more so, since they have been made of agglomerate, the base of which is the Fontainebleau sand, so fine that it never is used even for making mortar. It would not be possible to find a more complete demonstration of the value of our process, since even with Fontainebleau sand we accomplish the boldest works; and so completely has this won the confidence of the engineers, that eight bridges, of from one hundred to one hundred and fifteen feet span, which were to have had iron stringers, are now to be constructed entirely of agglomerate. This fact, more than any thing I could say, bears testimony to the value of this material.

"It is also with agglomerate, having for its base impalpable sand, that we are building the underground portions of the aqueduct, which pass through enormous masses of fine sand, and demand constant precautions to avoid caving. We have been compelled to adopt an entire system of sheathing and of centres especially adapted to the work. Success has so well attended our efforts, that we have, up to this time, met with no accident, and in spite of the manifest inferiority of the sand used, we have succeeded in running a tunnel of a single piece without a joint, the hardness of which is all that could be desired, with strength enough to resist, easily, the great pressure arising from the tendency to cave in of the running sand through which the work passes.

"We have thus proved, a second time [the first having been in the tunnel of the grand sewer of Saint Denis, under the Railroad du Nord], that the use of agglomerate for the construction of tunnels and underground work possesses a great superiority over common masonry.

"In fact, while common masonry leaves spaces behind the sides and above the arch, the agglomerate, by its very nature, crowds back the surrounding soil, compresses it, and fills all spaces, so that the entire circumjacent mass becomes incorporated with it, thus manifestly securing great solidity, largely increased by the absence of all joints, by which all leaking is prevented, which is the frequent cause of the accidents which so often happen in tunnels. A tunnel constructed of agglomerate is a monolithic tube without joints, homogeneous throughout its entire mass, and sustaining pressure with the maximum power of resistance.

"I have, moreover, in the construction of the aqueduct of Vanne, solved one of the most interesting problems. I have succeeded in rendering filtration 'absolutely impossible—'mathematically' so, to employ the expression used by the Government inspectors in their report, and this, too, without having recourse to the usual linings or coatings. These linings, you know, often have a thickness of several inches, and are then quite expensive; but their

chief defect, especially when applied to agglomerate, is a tendency to detach themselves from the masonry on account of the inequality of expansion, and to crack when the cement used is not of the first quality. The success has been complete and absolute; subjected to trial, the loss of water was nothing.

"This method, stopping all filtration, is of great advantage in the construction of basins, cisterns, and reservoirs made with agglomerate; works which, in general, it is so difficult to build without a tendency to leak, and upon which the action of the weather is so frequently injurious.

"As a proof of the confidence to-day given to agglomerate, I will instance the hollow blocks which we have constructed for the dock at Bordeaux, and also the sewers of Odessa, which have been constructed by this process.

"Above all, I will call your attention to the construction of the light-house at Port Saïd, which has just been intrusted to us.

"This light-house will be one hundred and eighty feet high; it will be entirely built of agglomerate, made from the desert sand, analogous to that of Fontainebleau; and it will rest upon a monolithic block of agglomerate of nearly four hundred cubic yards dimensions. It is almost an exact copy of the Baleines light-house, executed after the plans and under the orders of Mr. Léonce-Reynaud, Engineer-in-Chief. When it shall have been completed, I will have the honor to submit to you a special report upon this remarkable work.

"I have now called your attention to the principal works, more or less monolithic, which we have executed, and it remains for me to present to you certain applications and improvements, not less important, which we have accomplished in the adaptation of artificial stones to all kinds of buildings; but, before this, allow me to offer my tribute of thanks to those eminent men, Messrs. Belgrand and Alphaud, engineers, and Mr. Caillat, architect, who were the first to grasp the great future of the agglomerate, and did not fear to take the initiative in its use on a large scale. Permit me also to thank Mr. de Lesseps, the distinguished man who assumed the responsibility of awarding the construction of the light-house of Port Said to us.

"As I have before said, the result of our process increases twenty-fold, and even more, the adhering properties of lime and cement, so that by our method *we do make stone* which resists a crushing weight of considerably over seven thousand pounds to the square inch.

"It is evident that we have found this wonderful hardness of great use to us in the construction of flag-stones, flights of stairs, door-steps, landing-places, parapets, curves, balusters, etc.; and in fact, we not only daily deliver these articles to private individuals, but we have furnished large quantities to the city of Paris. I will particularly mention the stair-ways to the cellars of the Grand Opera House, which have given every satisfaction to Mr. Garnier, the architect of this beautiful structure.

"Besides being able to obtain, simultaneously with stability, color, grain, and finish of form, we have gone largely into the manufacture of ornamented and moulded stones; our reproductions of sculpture are true works of art. Ornamented stones for buildings, doors, windows, balconies, cornices, and balustrades, by universal consent, have been brought to perfection; and as we offer all these at prices notably less than those of ordinary stone, the demand for them increases daily."

Extract from Reports of U. S. Commissioners, Paris Universal Exposition, 1867, on Beton-Coigne't, by Leonard Beckwith, Civil Engineer:

Different varieties of béton-coignet tested at the Conservatoire des Arts et Métiers give the following results, indicated in the annexed table:

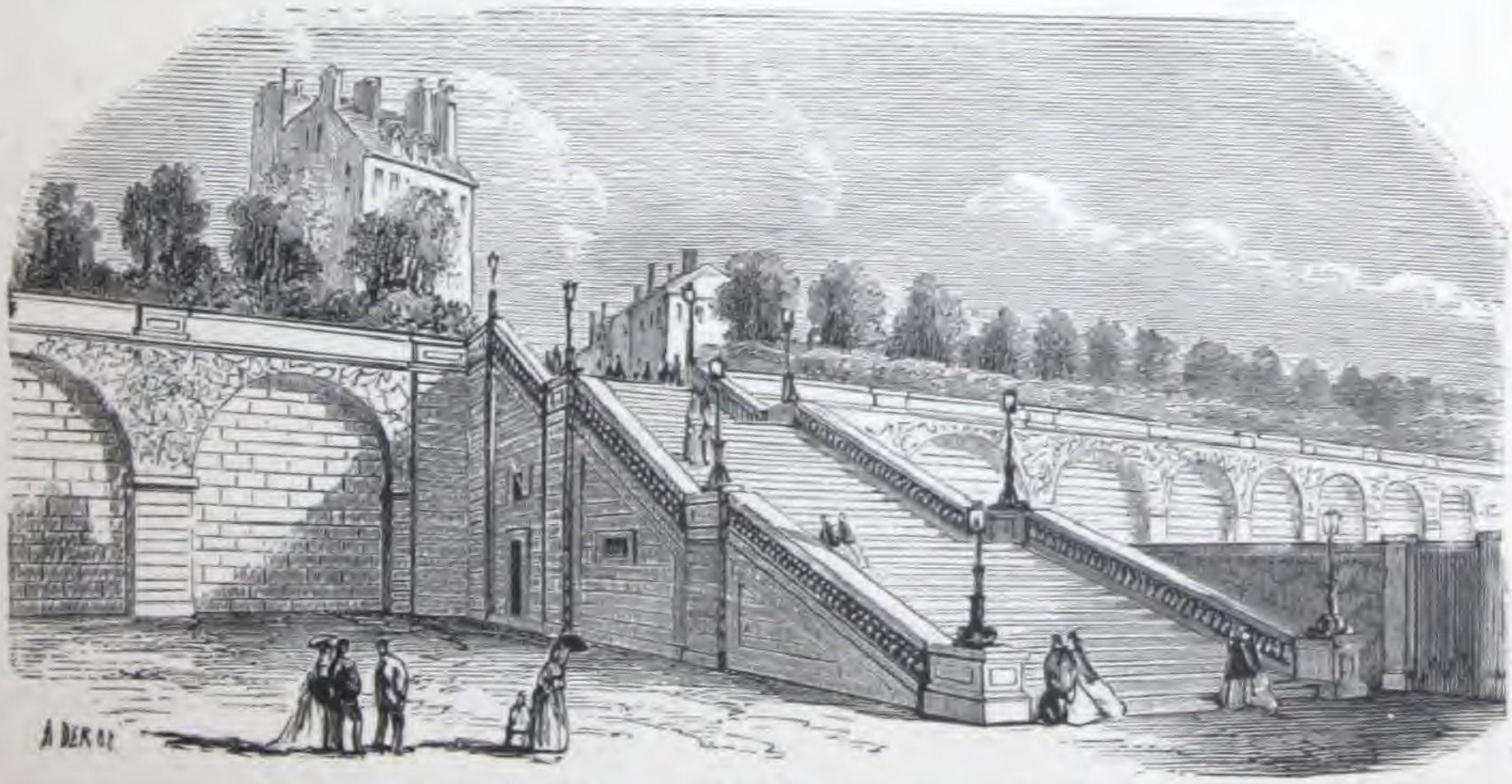
Experiments on the Crushing Strength of Coignet Agglomerate, made at the Conservatoire Impérial des Arts et Métiers, by Mr. P. Michelot, Chief Engineer in the Ponts et Chaussées, Paris, July, 1864. Dimensions calculated to nearest ¼inch.

Date of Fabrication of the Samples.	Age of the Samples.	Dimensions in Inches.			Weight in Pounds of a Cubic Yd.	Crushing Strength in Pounds.		Remarks.
		Length.	Breadth.	Height.		Total.	Per Square Inch.	
February, 1862*..	Yrs. Mos. 2 6	3 / 2	2¼ / 1	3¼	3508	28,240,216 / 35,744,372	3269.56 / 4130.77	Fissured Composition of vaults of City Barracks.
January, 1862*....	2 7	3 / 2	2 / 1¾	2¾	3665	44,641,073	4545.56	The small lateral prism was first crushed, but large prism resisted well.
January, 1862....	2 7	3	2	3¼	3521	24,893,170	4171.78	
February, 1863*..	1 6	3 / 2	2¼ / 1	3¼	3747	34,638,544	4039.64	One corner of the sample was damaged previous to the experiment.
February, 1862...	2 6	4	3¼	4	3831	72,457,942	5649.58	
November, 1862..	1 9	3	2¼	3¼	3950	46,874,651 / 50,109,772	7175.89 / 7495.07	Fissured.
November, 1862*.	1 9	3 / 2	2¼ / 1	3	3821	48,018,896	5549.00	
November, 1862*.	1 9	3 / 2	2¼ / 1	3¼	3774	33,467,443	5364.38	
May, 1863*.....	1 3	3 / 2	2¼ / 1	3¼	3604	23,462,325	2682.48	Composition of the Church of Vésinet.
May, 1863.....	1 3	3 / 2	2¼ / 1	3¼	3611	23,051,608	2634.14	
1862....	.....	2	2	3¼	3518	16,821,228	4012.48	

* The samples marked with an asterisk have the form of a T. The double numbers in the columns of length and breadth indicate the size of the two rectangles composing the total surface.

Most of the bétons in the preceding table are stronger than is necessary for ordinary uses, and if used, the thickness of the structure, as compared with common masonry, may be diminished.

Light-House, Port Said, entrance to Suez Canal.
Erected in 1869. 200 feet high.



Stair-way to the Avenue de l'Empereur. Built in 1866.

The tensile and bearing strength of bétons is variable, as is that of every kind of stone. The following table shows the range of strength in the particular kinds, and the relative strength of the different kinds of building materials named:

	Mortar.	Concrete.	Brick.	Lime-stone.	Sand-stone.	Coignet Agglomerate.	Granite.
Crushing strength in pounds per square inch.	280 to 2100	....	550 to 1700	4000 to 5500	2200 to 5500	2634 to 7495	5500 to 11000
Tensile strength in pounds per square inch.	50 to 290	77 to 360	115 to 300	120 to 864	180 to 900	288 to 426	

A cubic foot of béton-coignet weighs about one hundred and forty-five pounds.

APPLICATION OF BETON.—*Conclusion.*

WAREHOUSES, CHURCHES, GRANARIES, CELLARS, FOUNDATIONS.

Structures and buildings of solid masses of béton suffer less than ordinary materials from unequal settling of the ground, and underground rooms and cellars built of it are particularly free from damp.

The railway station at Suresnes, several houses at St. Denis, the church at Vésinet, etc., are examples of this kind, and, from the absence of joints, are the same as if made of one block of stone.

Cheap dwellings for workmen are now in course of construction in several localities in France.

A small house of béton-coignet was exhibited at the Champ de Mars, with specimens of arches, piers, slabs, statues, fountains, etc., finely moulded and well made by Mr. Coignet.

ARCHES AND VAULTS.

Various experiments have been made, with good results, to test the strength of the béton for arches, and it is now much used for that purpose; in the structures of the Northern Railway at Paris, in the new prison of the Madelonnettes, and in the new barracks of Notre Dame. In the latter, an arched vault was built of 18 feet span, 1½ feet versed sine, 8½ inches thick at the crown, with surface of 14 square yards, on which experimental weights of 47 tons were placed for a fortnight without damage. Béton was afterward used for all the similar arched vaults in the building, giving a surface of 3,588 square yards.

An experimental arch on the Quai de Billy has a span of 55½ feet, versed sine 4 feet, thickness of crown 14 inches, with good results.

At Aubervilliers, the machinery of a considerable saw-mill is placed on an arch of 33 feet span, versed sine 6½ feet.

The ventilation of the Exhibition building, at the Champ de Mars, is effected by underground works, consisting of a series of circular and railed galleries, arched with béton, span about 10 feet, for the circulation and supply from below of cool air through openings in the floor.

Bridge of Beton-Coignet.

The outer gallery is 33 feet in width, and 1,443 yards in length; the groined arches of béton are supported on two rows of béton pillars, 864 in number, carrying a roof, the upper surface of which forms a floor of 15,873 square yards of surface.

The quantity of béton consumed in these galleries was 353,166 cubic feet.

WALLS.

The embankment on which runs the Avenue de l'Empereur, at the Trocadero, for a quarter of a mile, is supported by a wall of béton about 40 feet high; the outer side is strengthened by pilasters; the inner side consists of a series of arches at right angles to the wall, built one upon the other, and extending into the embankment, forming a bearing for the mass of earth, and diminishing its lateral pressure against the wall. The walls and arches are a solid mass of béton.

The steeple of the church of Vésinet is constructed of béton, 130 feet high, and shows no sign of weakness.

FLOORS, TERRACES, ROOFS.

If the area does not exceed 13 or 16 feet in width, a slab of béton 10 or 12 inches thick will be strong enough to sustain itself; if the area be greater, double T-joists of iron should cross the space for ceilings, floors, etc., and the slabs of béton may be made thicker or thinner, depending on the distance of the joists one from another, the flanges of which form the holding of the slabs.

Joists being thus placed, and a temporary scaffolding or floor of boards erected underneath, the béton is dumped upon it and packed; the edges hold upon the flanges, the béton hardens, the scaffolding is removed, and the ceiling remains firm; if the upper side should serve for a floor also, the béton should be laid thicker and carried over the joists, so as to form a smooth surface above them.

FLAGGING SIDEWALKS.

Béton, being impervious to water, and without joints, no moisture is absorbed beneath, if the ground be properly drained, therefore no heaving or disturbing results from frosts in the ground. Flagging and floors of béton for courts, stables, cellars, coach-houses, schools, railway stations, warehouses, etc., etc., are much used.

FOUNDATIONS FOR MACHINERY.

Foundations for machinery, of béton, are usually cheaper, and as good as masonry of stone. For engines, a cubic yard of béton corresponds to a horse power, and a thirty-horse power should have thirty cubic yards of foundation.

Foundations of béton for water-wheels and turbines may be seen at St. Maur; for steam-engines, at the percussion-cap factory at Paris, the tobacco factory at Châteauroux, the glass works at St. Gobain, etc.; at Oyssel, a steam-engine of four hundred-horse power, which works admirably, rests on a block of béton 7 yards in thickness, and at the Exposition of 1867 a great portion of the machinery was placed on béton foundations laid in winter, and worked well.

SEWERS, AQUEDUCTS, WATER-PIPES.

Twenty-five miles of main sewers in Paris have been made of béton, and its use for this purpose is rapidly increasing.

Water-pipes of béton are made at half the expense of iron, and they cost little for repairs. The whole of the underground drainage of 40 acres roofed by the palace of the Exhibition, was through béton-coignet pipes of 12 to 16 inches tube, discharging into sewers of béton. The cubic contents of materials used in these pipes amounted to 264,825 cubic feet.

These, when built of masonry and coated with cement, are impervious to water, but need constant repairs; of béton-coignet they are equally impervious, cost less, and are more secure.

A cistern 39 feet in depth, 5 feet in diameter, with sides 10 inches in thickness, after two days receives water, and remains sound an indefinite period.

The cesspools of béton, authorized by the Prefect of the Seine in 1862, are without cement, hold good, and are water-tight; structures of this kind are adopted for the great opera house now building, and for the great railroad stations, etc., etc.

Gasometer tanks of large dimensions, 130 feet diameter, 49 feet in depth, are built of common béton-coignet at Rueil and St. Denis. The difficulties of making structures of this size in masonry water-tight are said to be much less in béton-coignet.

MARINE STRUCTURES—EXPERIMENTS OF MR. COIGNET.

Mr. Coignet's first experiments were begun, by order of the Government, in November and December, 1858, and January, 1859, on the Socoa breakwater at St. Jean de Luz, in a very exposed situation. The blocks were of several kinds, and all are alike in good condition at this date (1867), and have resisted the action of sea-water with satisfactory results. They are compact and hard, and the only effect noticed has been the wearing of the edges of the blocks and the rounding off of the angles, produced by the friction of pebbles and the general mechanical action of the sea.

Buildings of Beton-Coignet, Rue Miromenil, Paris.
Built in 1867.

Church in Vesinet, France. Built of Beton-Coignet, 1863.

From "Appleton's Journal," October 2, 1869.

NEW ARTIFICIAL STONE.

THE MATERIAL.

The manufacture of artificial stone has long been one of the unknown, or perhaps we should say, the *lost arts*, and time and time again, sanguine or designing inventors have announced their success in the construction of a concrete possessing all the properties of the most durable stone; yet, when these wonderful inventions have been put to a practical test, they have proved their worthlessness, and the fictitious stone has disintegrated and crumbled into its original dust. Most practical men had reluctantly come to the conclusion that the effort to substitute for the operations of Nature's laboratory the work of man was forever destined to remain a failure, when, some seventeen years ago, M. Coignet, a French inventor, made a discovery in reference to the manufacture of stone, or, as he terms it, béton, which induced him to believe that he had the key to the mystery in his hand, and he at once inaugurated a series of experiments, which have resulted so favorably as to have stamped his great invention with the seal of official French approval.

The discovery made by M. Coignet was merely the observation of a circumstance, so simple that it would seem to suggest itself to the most casual observer, and yet was probably for that very reason overlooked. From that observation, he deduced the cause of all previous failures. The problem now became this: Given the chemical constituents of any particular stone, to combine them so that all air should be expelled from between the particles, and they should form a homogeneous mass. The problem was one easy of theoretical solution, and the practical result is to be seen in the numerous massive structures which have been built from the new material here described.

Though this discovery was naturally looked upon with distrust during the first few years, repeated trials finally satisfied even the scruples of the French Government engineers, and numbers of public works were undertaken in which béton-coignet was used instead of stone, it having been definitely ascertained that it had a strength superior to any stratified rock, and equal to any of the harder rocks, except the very best quality of granite.

THE GRAND AQUEDUCT

from the river Yonne to Paris is to be thirty-eight miles long, and when completed, will be a single stone for the whole distance. It is, like our own Croton Aqueduct, carried under hills and across deep valleys and running streams. Our illustration represents a section of a viaduct, with a portion of one of the broad flights of steps which are provided at necessary points. There are many other places where more picturesque or attractive views might have been taken, but this was selected as showing at a glance three different grades of the material, and giving an idea of the method of construction.

One of the peculiarities of the construction of this great national work is the manner in which some of the tunnels are being made. They pass through sand hills, and, as the excavation progresses, the very sand taken out of the bore is mixed with the other materials, and in this form returned to its original location, thus obviating the necessity of the great expense of transportation which would be incurred were the material either stone or brick. The engineers of the aqueduct claim that it will be of sufficient strength to resist any possible pressure that may be brought to bear upon it, and that it will be absolutely impervious to water, which is certainly essential.

THE BRIDGE,

which forms another subject of illustration, is one of many which are now being erected in various portions of France, for government roads, for railroads, and for corporations, and gives

another instance of the wonderful strength of the material, as well as its adaptability to the most varied uses. So strongly does it cohere, that arches of great span and so little curve as to seem almost flat, will sustain an incredible weight. One constructed as an experiment on the Quai de Billy, has a span of fifty-five feet, a versed sine of four feet, and a thickness at the crown of only fourteen inches, and this has supported an extraordinary weight.

One of the most striking examples of the use to which this artificial stone has been put, is that of the

CHURCH AT VESINET,

erected in 1863 (see illustration), and which from foundation to the apex of the cross surmounting the spire at the height of one hundred and thirty feet, is, from the absence of any joints, practically and literally one solid stone, including roof, floors, belfry-lattice, steps and ornaments. Having commenced at the foundation, the work never stopped; the material was continually added, the rammers steadily used by the workmen, and the moulds constantly raised or changed as the exigencies of the case demanded. The result is one of the handsomest, cheapest, and most durable buildings in all France.

Irregularity of outline is no impediment to the work, as the material can be forced into the most minute crevices, and it was therefore an easy matter to give this church the appearance of being built of blocks of cut stone, the moulds having been creased so as to represent the joints which would necessarily appear in the walls, and the ribs always prominent in a roof of corrugated iron. This church was built in the spring of 1863, and, from motives of economy, was constructed of the very cheapest quality of béton-coignet, costing but little, if any more, than brick per cubic yard, and being only able to resist a pressure of 2,634.14 pounds per square inch, while the material which is used in the construction of the Grand Aqueduct is able to resist a crushing force of seven thousand four hundred and ninety-five pounds to the square inch, and costs scarcely half the price of stone per cubic yard, and, for the more ornamental work, less than one-third.

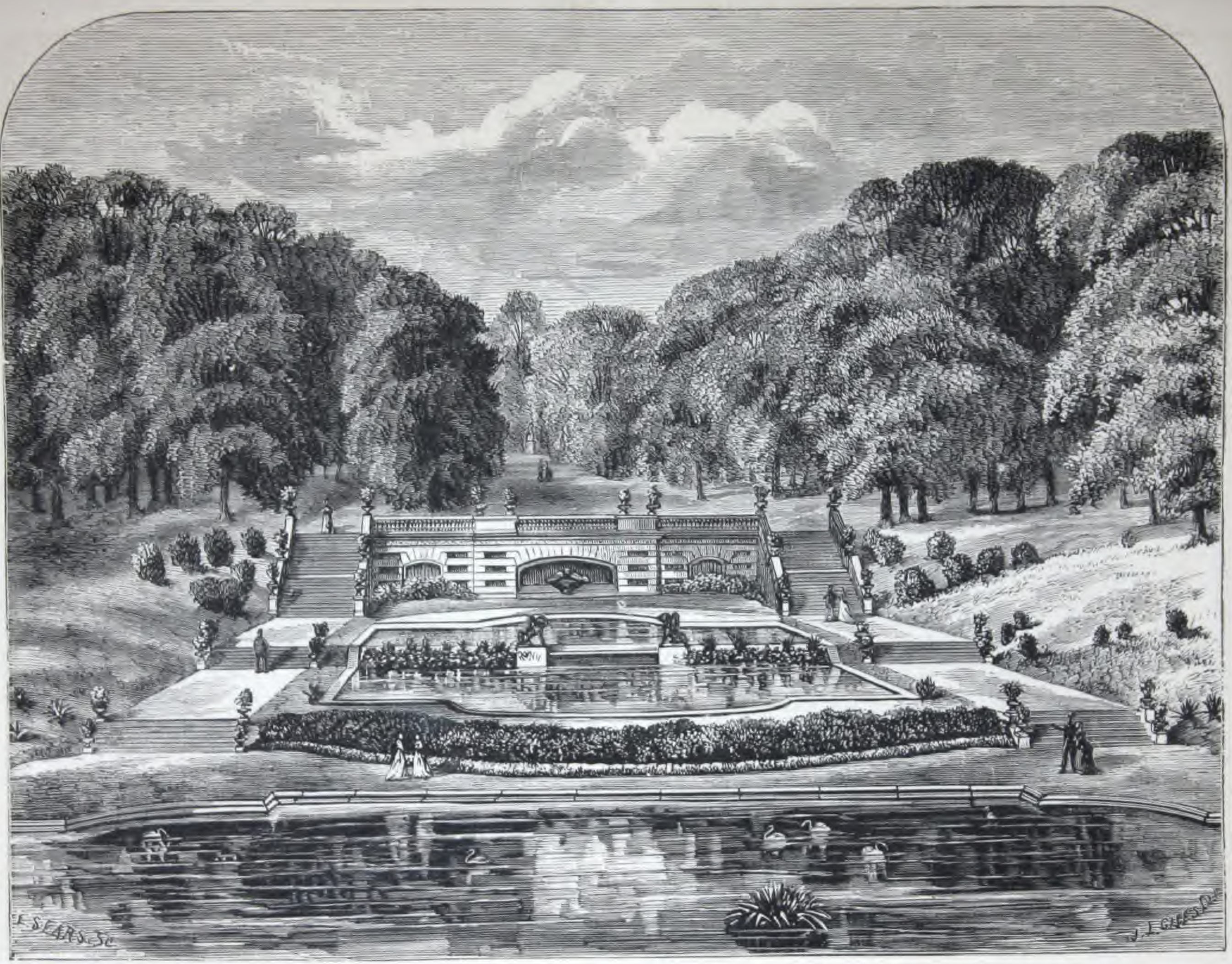
We give an illustration of the terrace and ponds in the

GARDENS OF RENTILLY, INCLUDED WITHIN THE EXTENDED WALLS OF PARIS.

These gardens, with their grand old forest trees, broad alleys and superb statuary, are noted for their beauty, and nothing of an inferior character can find a place within their bounds. It was therefore a conclusive testimonial to the estimation in which this béton-coignet was held when, instead of cut stone, it was selected for the construction of the basins, fountains, and surrounding ornamental masonry in these gardens. The imitation of masonry is exact, the joints being carefully marked, and the appearance of different kinds of stone being produced by the introduction of metallic oxides, so that while the walks, steps, balustrades, borders, and statuary represented in our cut are really one solid mass, without a joint or fissure they appear to have been constructed in the ordinary manner, and with ordinary materials.

GRAND COLLECTING SEWER.

Though not a subject of illustration, the grand collecting sewer of Paris is one of the greatest triumphs of the use of this béton, since the work was prosecuted in the face of the most disheartening difficulties, and that, too, without an accident of any kind. For great portions of its length it was alongside an old sewer, the foul waters from which were continually making their way through its crumbling walls and flooding the excavations for the new work. Five successive times did the waters of the Seine burst into the cuttings, and ye the work progressed with steadiness and such success, that the government inspecting engineers in their report announce that it is a monolithic tube, "absolutely and mathematically impervious to water. In addition to this report, E. Belgrand, the Inspector-General of Bridges and Roads and Superintendent of Drainage and Sewers for the city of Paris, gave a certificate



Fountain and Reservoir (Gardens of Rentilly). Built of Beton-Coignet.

on the 16th of June last, that the sewer in question was in good condition, and constructed with great stability.

This béton-coignet was the material used at the Paris Exposition for all the drains and water-pipes, and was made the subject of an exhaustive report by Leonard F. Beckwith, C. E., one of the United States Commissioners, who, however, treated the subject more from a scientific than a popular point of view; yet the following passages are quoted, since they give authoritatively certain statistics which, as the unsupported statement of a journalist, would doubtless be received with incredulity by the masses of persons not personally conversant with the facts:

"Structures and buildings of solid masses of béton suffer less than ordinary materials from unequal settling of the ground, and underground rooms and cellars built of it are particularly free from damp.

"The railway station at Suresnes, several houses at St. Denis, the church at Vésinet, etc., are examples of this kind, and, from the absence of joints, are the same as if made of one block of stone.

"Various experiments have been made with good results, to test the strength of béton for arches, and it is now much used for that purpose; in the structures of the Northern Railway at Paris, in the new prison of the Madelonettes, and in the new barracks of Notre Dame. In the latter an arched vault was built, of eighteen feet span, one and a half feet versed sine, eight and a half inches thick at the crown, with surface of fourteen square yards, on which experimental weights of forty-seven tons were placed for a fortnight without damage. Béton was afterward used for all the similar arched vaults in the building, giving a surface of three thousand five hundred and eighty-eight square yards.

"At Aubervilliers the machinery of a considerable saw-mill is placed on an arch of thirty-three feet span, versed sine six and a half feet.

"The ventilation of the Exhibition building, at the Champ de Mars, is effected by underground works, consisting of a series of circular and radial galleries, arched with béton, span about ten feet, for the circulation and supply, from below, of cool air through openings in the floor.

"The outer gallery is thirty-three feet in width, and one thousand four hundred and forty-three yards in length; the groined arches of béton are supported on two rows of béton pillars, eight hundred and sixty-four in number, carrying a roof, the upper surface of which forms a floor of fifteen thousand eight hundred and seventy-three square yards.

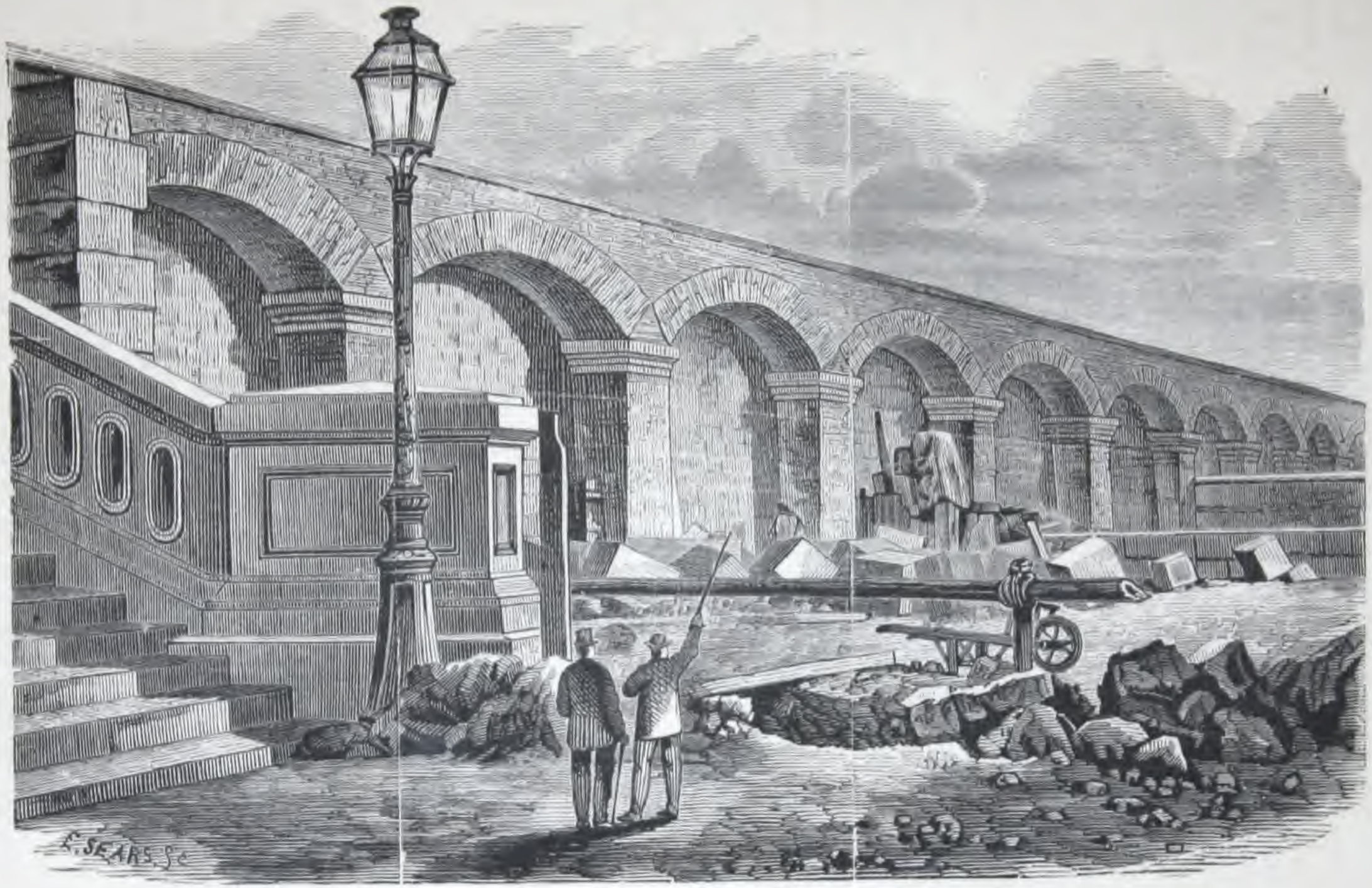
"The embankment on which runs the Avenue de l'Empereur, at the Trocadero, for a quarter of a mile, is supported by a wall of béton about forty feet high; the outer side is strengthened by pilasters; the inner side consists of arches at right angles to the wall, built one upon the other, and extending into the embankment, forming a bearing for the mass of earth, and diminishing its lateral pressure against the wall. The walls and arches are a solid mass of béton."

These must conclude our quotations from the report, from which, however, we learn the following facts: In building floors, terraces, or roofs, if the area does not exceed from thirteen to sixteen feet in width, a slab of béton ten or twelve inches thick will sustain itself; while, if the area should be greater, double T-joints of iron should cross the space to act as supports.

For flagging, nothing equals this material, since, as it is impervious to water and has no joints, no moisture can be absorbed beneath if the ground be properly drained, and consequently no fractures or upheavals by frost need be apprehended.

We further learn from the report that béton, as foundations for machinery, is "as good as and cheaper than stone;" that twenty-five miles of the sewers of Paris are now built of it, for the reason that "their construction of béton requires less time; the economy of masonry is reckoned at thirty per cent., and the saving on the whole work at twenty per cent.;" that "a cistern thirty-nine feet in depth, five feet in diameter, with sides of ten inches in thickness, after two days receives water and remains sound an indefinite period."

Not only upon land can this material be used instead of stone, but also for submarine struc-



Wall of Beton-Coignet, Paris. Built in 1866.

tures, even those requiring the greatest solidity; and, as a most striking instance of this, we quote the following from the description of the jetties at the entrance to the Suez Canal, given by Mr. E. Hepple Hall, in his article upon the Suez Canal, published as a supplement to *Appleton's Journal*, of the 31st of July:

"These jetties are constructed of what appear to be immense blocks of stone. They are not stone, however, but sand, dredged up from the bottom of the canal, mixed with hydraulic lime, and then put into wooden cases or moulds and allowed to dry. The lime is quarried a few miles down the canal, there ground, and thence transported to the works. Eight mills are kept constantly grinding on this novel, unique, and really interesting process. After sufficient time has been allowed to form and harden them, the wooden casings are removed, and the sun's rays, which in this latitude are intensely hot, complete the process of making the block. Two or three months suffice to harden them. They weigh twenty tons each, and cost about one thousand francs apiece. When sufficiently dry and ready for use, they are lifted up by a traveling steam-crane (*grue à vapeur*) onto trucks, passed to a tramway, and then pushed by a locomotive down to where the lighters are moored to receive them. They now take a short sea-voyage. After being transferred from the truck by another traveling crane, they are deposited in an inclined position, in rows of three, on another lighter, whence they are taken out to the position they are destined to occupy on the jetty, and there sunk. The rate of progress has been from thirty to forty blocks daily. Over fifteen thousand have been already submerged, and but little remains to be done to complete these magnificent piers. The dimensions of these piers, or jetties, are twenty-six yards at the base, six yards at the summit, and twelve yards in height."

The immense light-house now in process of erection at the same place is constructing of the same material. When completed, it will be one hundred and eighty feet high, and will rest upon a monolithic block nearly four hundred cubic yards in size, the whole being built of béton, having for its base the almost impalpable sand of the desert.

The proportions of the materials used can be so arranged as to permit of its being made on a spot subject to the ebb and flow of the tide, so that at the utmost it only has an exposure to the air during the interval between ebb and flow. This has been proved by experiment, and the material has been found to stand the test well; sea-walls of this material, placed for experiment, beside those of granite, having proved fully their equal; and, owing to the absence of joints, showing but faint traces of the action of the water.

Up to this point we have considered béton-coignet simply from a utilitarian stand-point, but we now propose to take it up as applicable to the

FINE ARTS.

And here an immense field is opened, for the finest qualities of stone can be perfectly imitated by the use of very fine grades of sand, and the minutest outlines and sharpest edges of a mould can be perfectly reproduced. Not only can duplicates of celebrated statuary be furnished with ease, and at an extraordinary small cost, but in the ornamentation of our public and private edifices there is no limit except that of design. The most extravagant taste for elaborate work can now be gratified without involving the outlay of fabulous sums, and the latest reports of the Parisian company state that the demand for ornamental work, of all descriptions, is already large, and daily increasing, as public confidence becomes more deeply rooted, and the fact becomes known that it is possible to gratify æsthetic inclinations, and, at the same time, observe rigid economy.

THE PYRAMIDS.

It has been suggested that the problem of the Sphinx, the Pyramids, and those Egyptian monuments whose hardness blunts the edge of our sharpest tools, while their weight defies the lifting capacity of our most powerful machinery, is now solved; and that, in discovering the method of making an artificial stone, M. Coignet has but discovered the rudimentary principles

of an art which, in its most perfect form, was familiar to the Egyptians. The question is, of course, but a mere speculation; yet should the supposition prove to be correct, how easy to account for these wonderful prodigies! A wilderness of sand around them, and no known deposits of such stone as forms them—what more natural supposition than that the material is but a high grade of the very artificial stone which is now being used at the Isthmus of Suez?

IN THIS COUNTRY

there have been many experiments in artificial stone, many announcements of success; yet that there has been invariably complete and irretrievable failures, must be too fresh in the memory of our readers to require more than a passing allusion. American capitalists, profiting by these failures, have been slow to purchase this French invention; but its success having been so triumphant in Europe, and on the strength of the report to which reference has been made, the invention has been patented in the United States, and the right purchased by some capitalists of this city, who have made arrangements for its manufacture on a large scale. The cost of the plainest work is far less than that of stone, while the moment that a comparison is made between curved and ornamental work in the two materials, the difference becomes absolutely startling.

We have for years felt in this city the want of some durable material for piers, wharves, and docks; and, if the manufacture of the agglomerate proves as successful in this country as in France, we have at last the means of attaining the desired end, and the mouldering, broken, dangerous ruins which deface the magnificent water-front of this city, can be replaced by enduring and ornamental structures at but small expense, as compared to what natural stone would be. In fact, there is, even here, where stone is comparatively plenty, scarcely a limit to the uses to which this béton can be put with great profit, while in those sections of the United States where stone is only to be procured at great expense and from distant quarries, it must be invaluable.

Report of T. A. P. Barnard, LL. D., President of Columbia College, U. S. Commissioner to the Paris Exposition.

The agglomerated bétons have been extensively introduced in France in the construction of heavy public works, and in the erection of private dwellings. Nearly forty miles of the sewers of Paris have been constructed wholly of this material. All the foundations and basements of the Palace of the Exposition, and other heavy structures in the Champ de Mars, those of the immense military barrack recently erected on the island of the city, the railroad bridge of Ste. Colombe on the road from Lyons to Marseilles, a very large number of substructures for private houses, some houses entire, and innumerable foundations for the support of heavy machinery, have been constructed in the same way.

The manufacture, as now generally practiced, was originated by Mr. Coignet, a French engineer, whose name is generally associated with the process.

The most important of the benefits which are to result from the use of the agglomerated bétons is probably to be looked for in the superior stability and strength which they are destined to give to the foundations and basements of ordinary dwelling-houses. The usual mode of forming such constructions at present is to employ a certain amount of cut stone at intervals, and to fill up the intervening spaces with rubble masonry. The entirely dissimilar character of these two kinds of masonry, with the great number of bonds or surfaces of junction between them, produces unequal settling and the consequent cracking of the walls. Walls which are constructed of agglomerated béton are not liable to such accidents. Their whole mass forms but a single homogeneous block, stronger than even the rock on which it rests as a foundation.

From the fact of their continuity, their weight is distributed over the entire area of the foundation, and no settling can take place so unequally as to produce fracture.

In a dwelling of five stories, in Miroménil street, Paris, constructed of a single mass of béton, a staircase of the same material runs in helicoidal form from the basement to the highest floor, moulded in the position where it stands.

At the Exposition, there were presented specimens of the various applications of this important material, including a pavilion, as illustrative of its adaptedness to building in mass lintels, cornices, friezes, paving slabs, troughs, garden benches and tables, vases, monuments, urns, statues, and nearly every other important object in which stone is commonly employed, whether for useful or for ornamental purposes. As scarcely ten years* have passed since Mr. Coignet's first experiments were made, and as it is only within the last two or three that the process has been perfected, or at least that its merits have been recognized, the béton aggloméré must be regarded as one of those new and useful things which the Exposition of 1867 was first to bring conspicuously before the world.

* Now seventeen years.

Reports and Opinions of American Engineers and Architects.

From John Y. Culyer, Chief Engineer Brooklyn Parks Commission.

BROOKLYN PARKS, OFFICE CHIEF ENGINEER,
April 6, 1873.

From a careful examination of the various artificial stones, so called, to which the attention of the public has been directed, I am led to believe that the material prepared by the Coignet process, and known as béton aggloméré, is best adapted for general use.

The materials employed in making this béton are such as will, in proper combination, form a very compact, strong, and durable composition; and inasmuch as the method of manipulation is absolutely uniform, and great care is given to the standard qualities of the cement, &c., used. I believe that the best results in the production of manufactured stone can be attained by the Coignet Company.

Of the strength and durability of the material manufactured under such circumstances, I think there can be no doubt.

A bridge, built under my supervision in Prospect Park, in the winter of 1871-2, under the most trying circumstances, perhaps, has now been subjected, substantially, to the action of two winters, and without any impairing results, and I have no doubt as to its continued durability.

Some of the best examples of pavement of this material have also been laid with like results.

There are so many uses to which this stone has been employed, that I assume there can be no obstacle in the way of its universal use for all works of construction to which it has been put, abroad—its successful use in our seaboard cities being, in my judgment, one of the severest tests to which it could be subjected.

The exceptional value of this process I believe to be in the thorough and uniform manipulation, by machinery, of the best materials, and in this respect I believe better and more reliable results will follow than from any other process now known to me.

Respectfully,

JOHN Y. CULYER,
Chief Engineer Brooklyn Parks Commission.

Cleftridge Span, Prospect Park, Brooklyn. Erected of Beton-Coignet, winter of 1871-72.

From Olmsted, Vaux & Co., Architects.

NO. 110 BROADWAY, NEW YORK,
March 28, 1873.

Dr. J. C. GOODRIDGE, Jr., N. Y. & L. I. Coignet Stone Co:

DEAR SIR—In regard to the Cleftridge Span, Prospect Park, the work seems to stand well so far, and gives satisfaction.

As this is the second winter that the main body of the work has been exposed, the result is decidedly encouraging.

I hope the large stones for the Fountain will get safely to the Park Plaza.

Yours, &c.,

CALVERT VAUX,
Olmsted, Vaux & Co.

From Q. A. Gillmore, Brevet Major-General U. S. A., and Major Corps of Engineers.

ENGINEERING OFFICE FOR FORTIFICATIONS,
NEW YORK, November 30, 1869.

GENTLEMEN—I have received your letter of the 15th inst., relative to the introduction into the United States of the agglomerates or bétons of Mr. François Coignet, under several letters patent granted to that gentleman.

This agglomerate possesses all the characteristic features of durability, as exhibited in natural stones, being close-grained, hard, strong and homogeneous, differing in these respects from every other kind of artificial stone which has been introduced to public notice. The soft and porous stones yield under climatic influence in consequence of alternations of heat and cold, causing disintegration on the surface, which becomes serous in cold climates when the stones are exposed to the weather, and are subjected to freezing and thawing. The proportions of the ingredients and the peculiar method of manipulation render the agglomerates exceedingly compact.

Careful chemical tests have shown the agglomerates to be practically impervious to water. Two small specimens, each weighing about 2½ grammes, were tried by Dr. Walz. They were immersed in water fifteen minutes and then kept four days in air saturated with moisture. One of the specimens did not increase in weight at all during the interval, while the other absorbed $\frac{16}{1000}$ of one per cent. or $\frac{16}{10000}$ of its own weight of moisture.

For the Vanne Aqueduct in France, 8½ inches have been found sufficient for a water-pipe having an inside diameter of 6½ feet, and the French engineer, M. Belgrand, certifies that "the impermeability appears complete."

The agglomerates will, doubtless, withstand the effects of frost, or extreme northern climates, as well as the natural brown-stones, limestones, and granites of equal density and hardness.

Plain walls can be constructed of it, either solid or hollow, at less than the cost of common brick masonry, and at less than one-half the cost of stone ashler, while for ornamental and carved work of all kinds, the advantages of the agglomerate are almost beyond comparison. Its peculiar character adapts it to the demands of every department of engineering, architecture, and sculpture, from the boldest public edifices to the most delicate and ornamental works of art.

It has been extensively employed in Europe—and with equal advantage may be applied in this country—for private residences, churches, and light-houses; for breakwaters, docks, aqueducts and sewers; for reservoirs, basins, cisterns, drain and water pipes, and for monuments, statuary, and other works requiring elaborate ornamentation.

While I do not profess to be familiar with the working of the patent laws of the United States, it is my opinion, which is shared by others with whom I have conferred, whose judgment in the matter is more valuable than my own, that Mr. Coignet's process, in its various applications, is fully protected by the several letters patent which have been issued to him.

I am, gentlemen, very respectfully, your obedient servant,

Q. A. GILLMORE,
Brevet Major-General U. S. A. and Major Corps of Engineers.

From C. C. Martin, Engineer E. R. Bridge.

OFFICE NEW YORK BRIDGE COMPANY,
Brooklyn, April 10, 1873.

Dr. J. C. GOODRIDGE, Jr., N. Y. & L. I. Coignet Stone Co.:

DEAR SIR—Having from the first taken a deep interest in the success of the béton-coignet in this country, I have frequently and carefully examined the work that you have executed, and have also subjected samples of your stone to the severe test of repeated freezing and thawing.

The result of my observations and tests is that I should not hesitate to use béton-coignet stone in almost any structure.

The facility with which elaborate ornamentation can be executed is one of the strong point in favor of your stone.

Very truly,

C. C. MARTIN,
Civil Engineer N. Y. Bridge Co.

From Lawrence B. Valk, Architect.

229 BROADWAY, NEW YORK,
February 24, 1874.

JOHN C. GOODRIDGE, Jr.:

DEAR SIR—I beg leave to state that in my experience in the use of Coignet stone it appears to have answered its purposes most admirably.

Of its durability there seems to be no question, as it grows harder by age and will not scale while its resistance to pressure is equal to the best natural stones.

It is capable of being worked in the most beautiful forms and in every style of architectural detail. All relief work is clear, sharp and distinct, and finer edges are produced than can be made on other stones.

It has been shown to my satisfaction that it is superior to Ohio or Nova Scotia stone, from being entirely free from wash, meaning that the brick-work or stone-work in which it is set will not become soiled by rain wash.

I am glad it can be made in any color or imitation of any stone. I have used it in several churches and it has stood remarkably well, and if I were to erect a very heavy warehouse I should not hesitate to use it extensively.

I desire to have it at least two months old before putting it in the walls.

I cheerfully endorse all you claim for it.

LAWRENCE B. VALK,
Architect.

From John Bogart, Esq., Chief Engineer Department of Public Parks.

DEPARTMENT OF PUBLIC PARKS,
OFFICE OF ENGINEER IN CHIEF,
New York, October 30, 1873.

The pavement laid for this Department by the Béton-Coignet Company, has now been in constant use in Broadway for more than a year.

It is in all respects excellent, and I am satisfied that in care in selection of material, in manipulation throughout the successive stages of manufacture, and in faithful adherence to the theory of construction, this Company has demonstrated both its ability and determination to do nothing but good work. In fact, I believe that entire confidence may be placed in the assurance of the Company, that only a thoroughly good pavement will be laid by its agents in the future, as has been the case with that already laid by them under my observation.

JOHN BOGART,
Chief Engineer Department of Public Parks.

To Dr. JOHN C. GOODRIDGE, Jr., N. Y. and Long Island Coignet Stone Company, Brooklyn.

From Wm. Field, Esq., Architect.

NO. 12 WALL STREET, NEW YORK,
March 27, 1873.

To the New York and Long Island Coignet Stone Company:

GENTLEMEN—In regard to your artificial stone called béton-coignet, I must say that I have had it under observation for a period of nearly two years, and have erected one building of it during the worst portion of this very severe winter.

The material is capable of very fine ornamentation, and has, during the time I have observed it, perfectly withstood all changes of temperature and exposure to the weather.

I believe it is a good building material, and preferable to the sandstones in ordinary use.

Yours,

WM. FIELDS,
Architect.

From Messrs. Renwick & Sands, Architects, to Mr. Valk, who was making inquiries of those who had used it before adopting it himself.

NEW YORK, March 29, 1873.

To LAWRENCE B. VALK, Esq., Architect:

DEAR SIR—In reply to your note asking us the opinion we entertain of the Coignet stone, I would say that the fact of Mr. Renwick's employment of it in the cathedral is the best endorsement he could give. He is away in Europe, but I know he thinks highly of it both in respect of its capacity for sustaining pressure and its resistance to the weather.

It is claimed for the stone that it will sustain from 5,000 to 10,000 pounds per cubic inch. The best specimens of it I have seen ring when struck, and show a hardness which is amazing.

Yours, faithfully,

J. SANDS,
Renwick & Sands, Architects.

From Samuel Wood, Esq.

No. 192 FRONT ST., NEW YORK.
November 21st, 1873.

To J. C. GOODRIDGE, Jr., N. Y. and L. I. Coignet Stone Co.:

DEAR SIR—The work around the Pavilion Hotel at Woodsburgh, L. I., and the Plaza laid with your pavement in the spring of 1870, is an excellent article.

It becomes hard very quickly, and in twenty-four hours is of sufficient strength as to be walked upon without damage, and in a few weeks is apparently as hard as granite. Teams are being driven upon it constantly without making any impression or at all affecting it.

The doubt I expressed to you, in regard to its adaptability to withstand the effects of frost (situated as it is near the ocean, and subject to the severe frosts incident to such an exposed location), is now fully removed from my mind. It does not crack, and shows no signs of being impaired in any way by the frosts of the past three winters.

I think it superior to the best flagging, inasmuch as it is less liable to crack under heavy strains; and in smoothness of surface and durability I think it at least equal to any natural stone.

Respectfully yours,

SAMUEL WOOD.

Extract from a communication of Dr. Isidor Walz, in reference to the absorption of moisture.

LABORATORY AND OFFICE OF DR. ISIDOR WALZ,
ANALYTICAL AND CONSULTING CHEMIST,
18 EXCHANGE PLACE,
NEW YORK, May 27, 1869.

DEAR SIR—At your request, I have examined a specimen of béton agglomerate, and found its specific gravity to be 2.305. I have also tested its power of absorbing moisture, and found the latter to be almost imperceptible. Two pieces were immersed in water for fifteen minutes and then placed under a large desiccator-globe, with a bowl of water under it, to keep the air inside saturated with moisture. After four days, the specimens were taken out and weighed. The first had not increased in weight at all, while the second, weighing originally 2,4650 grammes, had increased to 2,4790, having absorbed 0.16 per cent. of moisture.

Respectfully yours,

DR. I. WALZ.

Extract from the Thirteenth Annual Report of the Brooklyn Park Commissioners, for the year 1872.

FOUNTAIN.

During the summer and fall season the temporary fountain was in daily use, with the exception of a short period, during which the supply was so limited as to barely meet the more urgent demands of the city. The railing surrounding the basin has been cast and bronzed, and will be ready to set up as soon as the weather will permit. The dome of artificial stone for the fountain at the Plaza, manufactured by the Long Island Coignet Company, has been prepared, and is now ready for delivery. It is intended to put it in place during the ensuing season.

Early in the season the New York and Long Island Coignet Company resumed work on Cleftridge Span, and completed so much of the arch as remained unfinished at the date of my last report. The roadway over the arch was thrown open to the public early in spring. An ornamental pavement of Coignet stone has been laid under the archway. All of this work has satisfactorily withstood the effects of a winter and summer exposure, exhibiting no marked signs of disintegration or other material defect. From our experience and observations, I am led to believe that the use of this material may be regarded desirable in many ways, a skillful and thorough manipulation of the material being alone necessary to secure uniformity and strength sufficient for all purposes of general construction.

JOHN Y. CULYER,
Chief Engineer.

Extract from the Report of Landscape Architects.

To the BROOKLYN PARK COMMISSIONERS:

The result of the contract with the Coignet Company for the erection of the Cleftridge Span, has been in the main satisfactory. The material appeared to withstand the effect of frost satisfactorily, and as it offered considerable advantages in molding *different* work, it was considered suitable for use in the centre of the Plaza basin. Its design was approved by the commission for the somewhat massive decorative structure required in connection with the jet distribution of the large fountain, and an estimate submitted by the Coignet Company proving satisfactory, a contract was made with them for the execution of the work, which is now in progress, the material used being of the ordinary natural color of the sand and cement out of which it is constructed. Each of the main castings is of a complex, curvilinear, and somewhat cumbrous form; yet the lines are kept with remarkable exactness, no warping, expansion, or shrinkage being perceptible. This is a great advantage in repetitive architectural work, castings in other materials, iron or terra cotta; for instance, being so liable to inaccuracy that they can hardly be reckoned on to fit together with any degree of precision.

January, 1873.

OLMSTED & VAUX,
Landscape Architects and Superintendents.

From Major-General Q. A. Gillmore, U. S. A.

NEW YORK, December 27, 1872.

[EXTRACT.]

* * * * * *

The béton-coignet is by far the best artificial stone with regard to both quality and price that has ever been brought into use, and there is no doubt of its possessing all the requisite properties for withstanding all the alternations of heat and cold to which it would be subject in the severest climates.

Both the opinions and the practice of the European engineers concur on these points, and they do not hesitate to employ it in the boldest constructions on land and in the sea.

It hardens from precisely the same causes which give all their value to cement concretes, but under much more favorable conditions for density and ultimate strength,—and we can therefore point to concrete constructions in France, England and Northern Europe that are nearly fifty years old, and are better to-day than when first erected, for ample evidence of its durability.

A material which, at about the cost of good brick masonry, can be rapidly produced in any dimensions and in infinite form,—as well in monoliths larger than St. Peter's, as in the most delicate and highly embellished works of art and *vertu*,—cannot have other than a most fruitful future in this age of progress and practical ideas.

There is in my mind not a particle of doubt as to the great value of the stone for all important work in our climate, and even in the Canadas.

Very respectfully,

Q. A. GILLMORE,
Brevet Major-General U. S. A.

Certificates from French Engineers and Architects.

GENERAL DEPARTMENT OF TOBACCO.
OFFICE OF CENTRAL SUPERINTENDENT OF BUILDING,
PARIS, 25th of February, 1863.

I, the undersigned, Engineer of the Central Tobacco Department, certify to the accuracy of the following facts :

In 1860, Mons. Coignet constructed at the tobacco manufactory at Chatereaux, for the foundation of two steam-engines of twenty-five horse-power each, a single block of agglomerate about one hundred and thirteen cubic yards in size.

This block became hard without showing cracks or other defects, and the engines, after running steadily for two years, have caused no deterioration thereto.

In 1862, Mons. Coignet constructed at the tobacco manufactory at Paris-Renilly, for the foundation of a steam-engine of fifteen horse-power, a block of agglomerate about twenty cubic yards in size, and to this time this block has answered perfectly.

DEMONDESIR.

PARIS, April 14, 1863.

The undersigned, architect, certifies that Messrs. Coignet & Co. have executed at the theatre of the Square des Arts et Métiers, several works in his agglomerate ; among others, vaults, supports, and perpenders under the stage. This work, perfectly executed, has given most satisfactory results.

The undersigned, therefore, presents this certificate as an evidence of his satisfaction.

CUSIR.

PARIS, May 14, 1864.

The undersigned, engineer-in-chief of bridges and highways, in charge of the drains and sewers of the city of Paris, certifies that, under his direction, Mons. François Coignet has constructed with the agglomerate of his invention sewers of different kinds, having altogether a length of about fourteen thousand yards ; that the masonry of these sewers presents a very satisfactory appearance and soon becomes very hard, and that the use of this agglomerate effects a saving of about twenty per cent. over other masonry, the total cost of sewer earth-work, and shoring-up being taken into consideration.

E. BELGRAND.

PARIS, May 17, 1865.

The undersigned, architect, certifies that he has used the agglomerate of Messrs. Coignet & Co., for that portion of the new Opera-House beneath the stage, for the steps of the stairs to the cellars, and for several vaults. He takes pleasure in recognizing the great merits of this agglomerate, as regards its hardness and homogeneousness, and would have made more general use of it, if, at the commencement of the work, he had known the satisfactory result of its use, to-day so thoroughly demonstrated.

CH. GARNIER,
Architect of the New Opera House.

PARIS, May 20, 1865.

I, the undersigned, Alphonse Pallu, Chevalier of the Legion of Honor, managing director of the firm of Pallu & Co., founder of the Park and Church of Vésinet, certify that this church was built by Mons. Coignet, entirely of the agglomerate of his invention.

I certify that, during the two years consumed by Mons. Coignet in the building of this church, the agglomerate, in all its stages, was exposed to rain and frost, and that perfectly resisted all variations of temperature.

I further certify that to this day I have never had cause to do otherwise than to congratulate myself on my connection with Mons. Coignet.

A. PALLU.

PARISIAN COMPANY FOR LIGHTING AND HEATING BY GAS,
141 FAUBOURG POISSONNIERE, PARIS.

I, the undersigned, certify that in October, 1864, acting in behalf of the Parisian Company, I caused to be constructed in the stables of its gas-works at La Villette, a flagging of the coignet agglomerate, placed on a foundation of gravel, and having a thickness of a trifle over three inches.

This flagging has sustained, very well, the wear to which it has been subjected for twenty months.

ARSON,
Engineer of the Works.

PARIS, May 29, 1869.

I, the undersigned, engineer of bridges and highways, sub-director of the Parisian Company, certify that I have recently inspected the flagging in question, and have found it in a perfect state of preservation. The grooves especially, designed to prevent the horses from slipping, appear to me as sharp as when first made.

CAMUS.

Report in Reference to the Use of the Coignet Agglomerates and their Numerous Applications in the Buildings of the Municipal Barracks of Notre, at Paris, by Mons. Calliat, Architect in Ordinary of the Fifth Arrondissement.

After a preliminary examination of the process of Mons. François Coignet, I believed it advisable to make, upon a large scale, its first experimental use, for the construction of public works, in building the Municipal Barracks of Notre Dame, at Paris.

I have used the Coignet agglomerate, or artificial stone, to the value of several hundred thousand francs, and, from actual experience, do not hesitate to affirm that I do not know of any building materials the use of which offer so much security, and which at the same time are applicable to such a variety of important works.

In fact, I have constructed all the arched ceilings of the cellars of these barracks in a monolithic form, after having subjected them to the most excessive and unusual trials.

These arches are very bold; they have a span of from twenty-two to twenty-five feet; they have a rise of one-tenth; they have a thickness of but 8.66 inches at the crown, and, nevertheless, they have supported, without sustaining the least injury, all the wheeling of the heavy materials used in the elevation of the building. They have been loaded with from thirteen to sixteen feet of sand; they have sustained violent shocks from the fall of iron columns and of large cut stones, without receiving any damage.

I have constructed, under the same form, all the ceilings of the three stories of galleries ranged above each other, and facing the interior.

The subterranean drainage, which includes from five to six hundred yards of sewers, is of the same material.

All the monolithic works are perfectly satisfactory, as is also the flagging of the stables, which is constructed, with complete success, with the coignet agglomerate.

I have made extended use of these agglomerates, and with the same satisfaction, under the form of artificial stone, the appearance, the hardness and the form of which leave almost nothing to be wished for.

In the same way, I have constructed all the mangers, feed-boxes, and water-troughs of the stables, the steps of the staircases, the cellars, and even a portion of the sculptural stones which ornament the upper portions of the façades (eagles with extended wings and the arms of the city of Paris). All these stones have given complete satisfaction.

After such incontrovertible proofs, I remain convinced that the Coignet agglomerates are a perfect triumph in the art of building, and that architects can use them with perfect safety for the most daring works.

CALLIAT,
Architect of the Fifth Arondissement.

PARIS, January 3, 1867.

P. S.—At the request of Mons. Coignet, the following tests were made, in order to try the strength of the vaults:

1. A mass of stone, weighing upward of 36 tons of 2,000 pounds, was piled upon the centre of one of the vaults, having a surface of 17½ feet square.

2. A mass of sand, over 13 feet thick, was spread over the whole surface of the same vault.

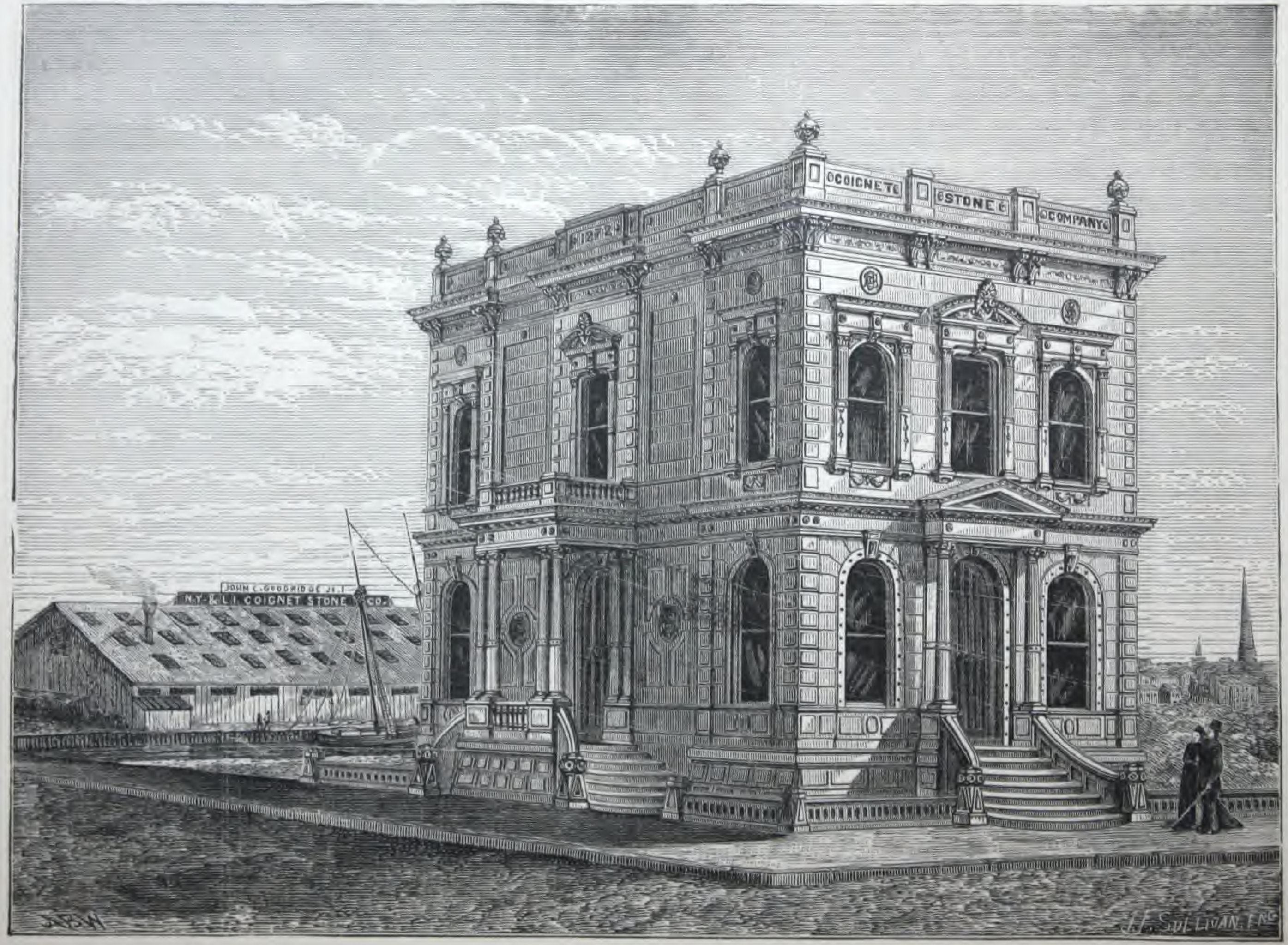
3. Carts loaded with heavy materials were driven over it, and in no instance was the slightest effect produced.

V. CALLIAT.

PARIS, November 15, 1867.

I, the undersigned, engineer of bridges and highways, attached to the construction of the Palace of the Exposition, certify that Messrs. Coignet & Co. have constructed with their agglomerate, for the said palace, certain works of the following description:

1. A system of herring-bone arches to cover the subterranean gallery, 1,472 yards of superficial area, which extends under the refreshment gallery, and which serves at once as a cellar and a means of ventilation. These herring-bone arches are comprised between the lateral walls of the submarine gallery, about 32 feet apart, and the iron cross-beams, about 50 feet apart. They are sustained by pillars about 14 inches square; their versed sine is about 11 feet; and their thickness at the crown is 5½ inches.



Office cor. 3d Avenue and 3d Street, Brooklyn. Built of Beton-Coignet, Winter of 1872-73.

These arched vaults were proved by a load of 2,200 pounds to the square yard.

2. A system of cylindrical arches to cover the ventilating passages, some radiating from the centre of the building, others concentric, the total surface of which is about 4,046 yards.

These arches have a versed sine of about 11 feet, are diminished one-tenth, and are nearly 8 inches thick at the crown. They were tested with a weight of 3,300 pounds to the square yard.

3. A system of sewers to carry off the rain and waste water, the surface of which is nearly 8,600 yards. The pipes are some of 12 and some of 16 inches diameter. The water is all carried off through a collecting sewer, similar to those of the city of Paris.

4. A system of flagging, including the three principal radiating galleries, and the three circular galleries of the palace, and forming a surface of about 7,937 superficial yards.

The works to which reference is made have, in general, been executed with care, and within the time prescribed by the contracts. This care is, moreover, an essential condition for the success of the Coignet agglomerate. The arches have perfectly sustained the proofs to which they have been subjected, and the flagging has borne without injury the immense travel which it has endured.

In fine, the works executed by Mons. Coignet have admirably answered the purpose for which they were designed.

DUVAL.

Approved by the engineer-in-chiet of bridges and highways, director of the works of the Palace of the Exposition.

PARIS, November 16, 1867.

KRAUZ.

PARIS, October 7, 1868.

I, the undersigned, engineer of bridges and highways, chief of the imperial commission, certify that the Messrs. Coignet have completed, in agglomerate, the sides and bottom of a reservoir of 19,685 cubic yards' capacity, intended for the supply of the Champ de Mars, and that this work, of a thickness of less than 4 inches, has proved perfectly satisfactory, in spite of 16 feet of water which pressed upon the bottom. It has given equally satisfactory results in regard to economy and resistance.

In testimony of which, I have given this certificate, for the purposes therein mentioned, to whom it may concern.

CHOYSSON.

PARIS, October 8, 1868.

I, the undersigned, architect of the imperial commission, certify that Messrs. Coignet have constructed, in agglomerate of their invention, the foundation of the chalet which was erected by M. Haret for exhibition in the Champ de Mars, and placed by him at the disposition of the Imperial Commission.

I moreover certify that the work has been performed with care and with taste, and has yielded very good results.

ALDROPHE.

EXPOSITION UNIVERSELLE OF 1867, AT PARIS,
PARIS, October 19, 1868.

SIR—I have the honor to inclose to you the certificates of the different chiefs of departments, who have respectively directed the works executed by your house in the Champs de Mars.

I see with pleasure that your house has handsomely acquitted itself of its task, and I gladly add the expression of my personal satisfaction.

Receive the assurance of my perfect consideration.

LE PEAY,
Senator, Commissioner General.

DEPARTMENT OF THE SEINE,
MUNICIPAL DEPARTMENT OF PUBLIC WORKS OF THE CITY OF PARIS,
BRIDGES AND HIGHWAYS.
OFFICE OF SUPERINTENDENTS OF DRAINAGE AND SEWERS.

The Inspector-General of Bridges and Highways, Director of Drainage and Sewers of the City of Paris, certifies that the Coignet Agglomerate Company has executed, under his direction, several important hydraulic works, namely:

1. *In the interior of Paris.*

One hundred and sixty-four thousand feet of sewers.

2. *Outside of Paris.*

One hundred and ninety-six thousand eight hundred and fifty feet of the Vanne aqueduct.

These latter works are in a fair way of completion, about one-third being finished. They include about forty-two thousand six hundred and fifty-three feet of underground work, in part through very fine sand. They also include *six bridges of one hundred and fifteen feet* span. The section of the aqueduct is a circle of seventy-eight and three-fourths inches diameter; the thickness of the walls is a trifle over eight and a half inches; and the impermeability appears complete.

In addition, the same company has executed, under the direction of the engineers of the department of the Seine, several sewers, especially the collector of the Plaine Saint Denis, which is thirteen feet one and a half inches in diameter under the crown, and nine feet ten inches laterally.

These works have been constructed with great stability.

PARIS, June 16, 1869.

E. BELGRAND.

NEWSPAPER EXTRACTS.

From the "Brooklyn Eagle."

Having reported, about a year and a half ago, the beginning of the manufacture of artificial building stone in Brooklyn, the *Eagle* has now to note the progress of this rapidly increasing branch of industry. At the time in question, the New York and Long Island Coignet Stone Company started the first establishment of the kind on this side of the Atlantic, at the corner of Hamilton avenue and Smith street. The whole establishment, including yards, sheds, and other structures, covered an entire area of sixteen city lots, and was capable of producing only sufficient finished stone for the front of an ordinary building daily. Since its inauguration, the Company has quietly continued operations at its old works, producing large quantities of stone in the shape of building materials, tiles, statuary

and general ornamental work, both for local use and for shipment to other places. Soon after beginning active operations, a rapidly increasing demand for the new material engendered the necessity for a large new factory, and accordingly one was begun on Third avenue, between Third and Sixth streets, the premises being located on either side of the Fourth street basin, but which extends to Gowanus Canal. The total area of ground acquired by the Company at this point is five acres, intersected, as stated, by the basin, but connected by a substantial swinging bridge. The factory building is of mammoth dimensions, covering a full acre of ground, and being thirty-two feet in height. The building, now completed and occupied, contains machinery and material for manufacturing purposes. Among the machinery is a massive hydrostatic testing press, by which a crushing pressure of 120,000 pounds can be applied. The new works are capable of turning out fronts for ten ordinary houses per day, besides a large quantity of fine ornamental work, and will give constant employment to an average number of a hundred workmen. Adjoining the new works, at the corner of Third avenue and Third street, an elegant and substantial building of artificial stone, 25 by 40 feet, and two stories in height, designed to be used for the offices of the Company, is now in course of erection.

The process of manufacturing this kind of artificial stone, which is fifty per cent. cheaper than natural stone when cut, was for centuries among the lost arts, but was finally discovered in 1856 by M. Coignet, a distinguished Parisian *savant*, from whom it received the name of Coignet Agglomerate. During a half century prior to this discovery, practically scientific persons had been vainly seeking the lost secret, expending large sums of money in futile experiments. M. Coignet having perfected his process, the subject was taken up by the French Government, which, after a series of official examinations, tests, and experiments, pronounced the agglomerate, or béton-coignet, as it is commonly termed in France, equal in appearance, strength and durability to the natural stone, and invulnerable to the effect of heat, dampness, or frost. By the Coignet patent, the constituent elements of the stone to be imitated are first ground down and mixed by machinery, and the mixture, when in a plastic state, is easily moulded. The moulds, after being gradually filled by a scientific process, which entirely excludes the air, are immediately removed, and the stone, which is ready for transportation in a few days, continues to increase in weight and density thereafter. At their manufactory, the Company exhibit specimens which have undergone ten years' constant exposure in summer and winter, and which still remain perfect in form, and harder than the natural stone, the agglomerate withstanding an average crushing pressure of over four tons to the square inch, which is about the average strength of natural granite, and three times that of brown or sand stone. There are also at the works many fine specimens of statuary, traceries and tiling of every shape and color.

Its use in Europe has been very extensive, and among some of the principal works of this kind of masonry across the ocean may be mentioned about forty miles of the famous sewers of Paris, the immense collecting sewer of which city was built by M. Coignet during five successive inundations of the Seine, but completed in perfect order, without joint or crack; sewers in Odessa, Russia, which have withstood the test of years; docks at Bordeaux; pavement at Lyons; the foundations and galleries at the Paris Exposition building; the government cavalry stable floors, the grooves of which remain perfect after years of service; the barracks of Notre Dame; the embankment of the Avenue de l'Empereur; the great railroad bridge between Lyons and Marseilles; the structures of the Northern Railway; the masonry of the Gardens of Rentilly, and numerous other public works and private residences.

The Aqueduct Le Vanne, which is considered as one of the most difficult but successful engineering undertakings of modern times, is also of this material, This aqueduct, which conveys water a distance of thirty-eight miles to Paris, is built upon the shifting desert sands of Fontainebleau, and consists of a series of immense arches of Coignet stone. All of these

arches are fifty feet high and fifteen and three-quarter inches thick at the crown, ten being ninety feet span, and eight of one hundred and fifty feet span. Upon these rests the aqueduct, six and one-half feet inside diameter, and with walls only eight and one-half inches in thickness. Eleven miles of the aqueduct are tunneled through quicksands, and the entire work of construction was carried on during both hot and cold weather.

The blocks of the Suez Canal and the light-house at its entrance are of the same material, the latter being one hundred and eighty feet high, and resting upon a solid block containing four hundred cubic yards of the agglomerate.

At Versignet there is also of Coignet stone a large church, including the doors and even the fine lattice-work of its windows.

In Brooklyn and vicinity the agglomerate seems to be rapidly gaining favor, there now being no less than forty-seven buildings, mostly of imitation brown and sand stone, finished and in course of erection in this city, as follows:

Thirty buildings for use as stores and offices, four stories in height, at the junction of Flatbush and Atlantic avenues, in course of construction by Mr. Vreeland, eight being already finished.

Five three-story and basement dwellings, by A. S. Barnes, on Clinton avenue, near Atlantic.

Five three-story and basement dwellings, by Mr. McCord, in the same section.

A building by Mr. Olsen, corner of Fourth avenue and Dean street, three stories in height, the first floor being for a store and the upper portion for a dwelling.

The office of the Coignet Company, corner of Third avenue and Third street, as above described.

Cleftridge Span, between the lake and the refectory, in Prospect Park, is also of Coignet stone. This structure, over which passes the road to Breeze Hill, is of a most elaborate style of architecture, of various colors of stone, the arch, which is also flagged with the agglomerate, being of twenty feet span and eighty-eight feet in length.

Stone is also in process of construction of the large fountain in the Grand Plaza.

The arches, columns and traceries of the great Roman Catholic Cathedral, corner of Fifth avenue and Fiftieth street, New York, were also manufactured by this Company, and fourteen teams are now daily engaged in transporting them from the works to the cathedral.

The windows and traceries of a church built at Staten Island by Mr. D. Appleton, the publisher, are also of this substance.

The plaza of the Woodsburgh Pavilion, at Rockaway, contains fourteen thousand square feet of the agglomerate, which has also been extensively used in the construction of public buildings on Ward's Island.

The National Government has had this article under examination and consideration for several years, and it was made the subject of a special and very complete report by Messrs. L. C. Beckwith, civil engineer, and Dr. T. A. P. Barnard, of Columbia College, who were the United States Commissioners to the Paris Exposition. With a view to ascertaining its adaptability for government works, General Gillmore was sent to Europe to officially investigate the matter. In his report, the General, who personally inspected the structures in Europe above described, states that after a careful examination he finds the Coignet stone adapted and adequate to the demands of every department of engineering, architecture and sculpture, being suitable alike for breakwaters, light-houses, aqueducts, sewers, reservoirs, residences, churches, monuments, flagging, statuary, and other works requiring elaborate ornamentation. In view of this report, the Government has adopted the Coignet stone, and is now using it, under the superintendence of General Gillmore, for the construction of the casemates, sallyport, floors, and other portions of Fort Wadsworth on Staten Island. Brooklyn, therefore, aside from having the honor of containing the first factory of this kind in America, is not only furnishing

material for dwellings, churches, and other structures, but is also manufacturing stone for the great national defenses, and has a fair prospect of monopolizing this important and growing business.

From the "New York Herald," August 15, 1869.

In an extensive and able article, published in the *New York Herala* of Sunday, August 15th, 1869, on the subject of SEWERAGE, DRAINAGE AND ROADWAY, the writer speaks as follows of béton-coignet, or the coignet agglomerate:

"The concrete known as béton-coignet differs from the ordinary road-bed concrete, in being an artificially formed sandstone of *great durability and strength, and of extensive application in civil engineering in all its ramifications*, from the manufacture of sewers to the construction of aqueducts; from the fabrication of road-beds to that of underground vaults of the utmost possible capacity. The best béton endures a crushing strength 4¾ times that of the best brick, 50 per cent. more than lime-stone, 50 per cent. more than sand-stone, and about 40 per cent. less than that of the strongest granite, to 35 per cent. more than that of inferior qualities—its durability being about the same as that of the best quality of sand-stone. The embankment on which runs the Avenue de l'Empereur, at the Trocadero, is supported by a wall of this material, forty feet in height, for the distance of a quarter of a mile, and in general the subject of its application is now being discussed and being experimented upon by the best engineers in France, with a view to extend to the utmost the constructive capacity in engineering of so inexpensive a material as that developed by the invention of M. Coignet, while in the *sewerage system* it is *rapidly superseding every thing else.* In it, no doubt, is, at the end, to be sought the *solution of the sewerage problem in this city*, if the administration thereof fall, with the needed powers of discretion, into the hands of a competent board of engineers. What is wanted in the problem is the boldness to break loose from worn-out ideas, and apply the best invention of the age to the development of a better and more adequate system, a quality which has been startlingly exhibited, with equally startling and successful results, in the administration of the Department of the Seine, and in the construction of public works in Paris for the past ten years."

From the "London Builder," December 26, 1868.

CONCRETE BRIDGES.

In a description given in the *Builder* about three months since of the works on the Metropolitan Extension Railway between Paddington and Brompton, an allusion was made, in passing, to an interesting experiment in progress across a wide cutting upon the metropolitan district line near Brompton station. We are now able to report the results of the experiment which was to test the tensile power of concrete. They are such as seem calculated to lead to the more extensive use of this description of building material. The structure to which the test was applied is an arch formed entirely of concrete, of 75 feet span, and only 7 feet 6 inches rise. It was 3 feet 6 inches deep at the crown, and of a uniform width of 12 feet. The materials and proportions employed were six of gravel and one of Portland cement, and dependence for cohesion was placed rather upon thoroughly mixing the materials than ramming. The tests successfully borne by this erection were 170 tons distributed equally over the top, and a train of seven trucks, weighing 50 tons, passed over it. There was practically no deflection under these weights.

From the "N. Y. Trade Reporter."

The Manufacture of Artificial Stone, the process and its uses—An Account of its Application as a Building Material in France, Russia, Egypt, and America—Scientific Reports by Leonard C. Beckwith, Dr. Barnard, U. S. Commissioner, and General Q. A. Gillmore, U. S. A.

The recent great fires, affecting not only those whose buildings have been destroyed, but the whole commercial interests of our country, have called attention to our building materials. The terrible explosion of granite when subjected to intense heat, and the crumbling of marble, becoming converted into lime, have diminished our confidence in what were supposed to be our strongest and most enduring materials. It has been found that artificial materials withstand heat better than natural, as brick, having withstood the test of years, is now recognized as a good material, the thought of its being an artificial product not being considered.

One of the most valuable and useful reports of the Paris Exposition of 1867 is by Mr. Leonard C. Beckwith, civil engineer. The author gives a history of what is known in Europe as béton-coignet, and a concise description of the processes and the results of experiments on its tensile and crushing strength. This report, printed by the State Department in 1867, would be more than an equivalent for all the expenses incurred, by bringing to our notice so important a material. This material is applied in France to a great variety of uses. Palaces, private residences, churches, archways, reservoirs, sewers, water-pipes, etc., are capable of being formed by a single piece of the greatest solidity, impervious to water, secure against the action of fire and frost, and capable of every variety of embellishment.

As many of our readers are unacquainted with this new material, and are not aware to what extent it is being used abroad, and the extensive use and demand that exist in this country, we give some extracts from the reports of Mr. Beckwith and Dr. Barnard, U. S. Commissioner to the Paris Exposition, and of General Q. A. Gillmore, who was sent to France by our Government, and whose report is published by authority of the Secretary of War.

It is now seventeen years since M. Coignet's béton was introduced into France. At first there was a great prejudice against it, and it was tried continually on minor structures. After two years of experiment, it was adopted by the French Government, and has since been used to a great extent. In Egypt it is largely used and employed on a vast scale, especially for light-houses. In Paris there are more than forty miles of sewers constructed of this material, The arches under the Exposition building and on which it was built, and which constituted a perfect labyrinth, attracted great attention from all engineers, and were sufficient to satisfy the minds of the most skeptical. Aqueducts are now being constructed for the purpose of supplying water to Paris. The distance from Paris to the source of the Vanne is more than ninety-four miles, and in its course the line has to traverse a series of valleys and ravines, and to cross roads and railways, and the numerous requirements of the work have involved the formation of extensive bridges, aqueducts, syphons, and tunnels. An immense reservoir will be completed, close to the park of Montsouris, and a large aqueduct upon arches has been made close to the old Roman aqueduct of Arcueil. The arches crossing the valley of Fontainebleau, a distance of about thirty-one miles, are the heaviest work of this great undertaking. Not only has the aqueduct been constructed of this material, but the tunnels also. The aqueduct is supported upon a series of arches extremely light, and rising to a height of fifty feet from the ground; the thickness of the arches at the crown is fifteen and three-fourths inches, and the spans from forty-two feet six inches to one hundred and twenty-six feet. In Paris the embankment on which runs the Avenue de l'Empereur, at the Trocadero, is supported for a quarter of a mile by a wall forty feet high. It has been found that béton-coignet is admirably adapted

for marine structures. The Suez canal, the docks at Boulogne, and numberless structures of this kind, bear witness to its strength and utility.

One of the important benefits to be derived from the use of béton is probably to be looked for in the superior strength and stability which it gives to all structures composed of it. The usual method employed in natural stone or brick and mortar, by a want of combination between two entirely dissimilar materials, with a great number of bonds and joints, prevents a perfect union of the various surfaces at the point of junction, and the result, of course, is unequal settling and cracking of the walls. Water also, washing away the mortar, leaves the separate blocks insecure. Walls of béton-coignet are not liable to such accidents, the whole being one solid homogeneous block. Dr. Barnard, in his report as U. S. Commissioner, speaks of the utility of the Paris Exposition in being able to bring this new material for the first time before the world.

The following are extracts from reports by General Q. A. Gillmore: This agglomerate possesses all the characteristics of durability as exhibited in natural stones, being close-grained, hard, and homogeneous, differing in these respects from all other kinds of artificial stone which have been introduced into popular notice. The soft and porous stones give way under climatic influence, in consequence of the alternations of heat and cold causing disintegration on the surface, which becomes serous in cold climates, where the stones are exposed to the weather and subjected to thawing and freezing. The proportions of the ingredients and the peculiar method of manipulation, render the agglomerate exceedingly compact.

Careful chemical tests have shown béton-coignet to be practically impervious to water. Two small specimens, weighing two and a half grammes, were tried by Dr. Walz, a New York analytical chemist. They were immersed in water fifteen minutes, and then kept four days in an atmosphere saturated with moisture. One of the specimens did not increase in weight during the interval, and the other absorbed 16-100 of one per cent., or 16-10,000 of its own weight. Béton-coignet will undoubtedly withstand the effect of frost or extreme northern climates, as well as natural brown stones, limestones, or granites of equal density. Its peculiar character adapts it to the demands of every department of engineering, architecture, and sculpture, from the boldest edifices to the most delicate works of art. It has been employed in Europe, and may be applied with equal advantage in this country, for warehouses, private residences, docks, aqueducts and sewers, for reservoirs, basins, cisterns, drains and water-pipes, and for work requiring elaborate ornamentation. It is the best artificial stone that has been brought into use, and there is no doubt that it possesses all the properties requisite for withstanding the alternations of heat and cold.

This material, like brick, which is also an artificial stone, is capable of bearing a greater heat than natural stone, and its adaptation for use in large masses, as the structure may be made much lighter with equal strength, as has been demonstrated by most extensive experiments in Paris, renders it, for many purposes, superior to natural stone.

The following table, taken from the report of Mr. Beckwith, shows the comparative strength of this material and of other substances employed for the same purpose:

CRUSHING STRENGTH IN LBS. PER SQUARE INCH.

Mortar.	*Brick.*	*Limestone.*	*Sandstone.*	*Béton-Coignet.*
280 to 2,100 ...	550 to 1,700 ..	4,000 to 5,500 ..	2,200 to 5,500 ...	2,634 to 7,490

TENSILE STRENGTH IN LBS. PER SQUARE INCH.

Mortar.	*Brick.*	*Limestone.*	*Sandstone.*	*Béton-Coignet.*
50 to 290 ...	115 to 300 ...	120 to 864 ...	180 to 900 ...	285 to 426

A cubic foot of béton-coignet weighs about one hundred and forty-six pounds. Stone much stronger than the specimens referred to in the above table, is now being made by the Coignet process, many samples having sustained a pressure of 12,000 pounds, or six tons, to the square inch.

Since the above reports were made, a large factory has been built in Brooklyn, at the corner of Third avenue and Third street, which is now in working order, and employs a force of about fifty men. The Company have also an elegant office, which is being erected as a specimen of their work,

This Company own the patent rights for this manufacture for the cities of New York and Brooklyn, and are doing work for both cities. Passers up Broadway have noticed at its intersection with Fifth avenue, the beautiful pavement laid round the Worth Monument.

This is made of the material which we have described, and was laid this fall. The Company are now building the new receiving tomb at the cemetery of the Evergreens, which will be a massive monolith, capable of holding five hundred bodies in its capacious catacombs.

From "Van Nostrand's Eclectic Magazine," April, 1873.

BUILDING-STONES.

We find in the columns of an Eastern daily—*Boston Advertiser*—an account of some recent experiments on the artificial building stones now prominently before the public. Although no test that can readily be applied can be satisfactorily substituted for the *weathering* to which the building materials of our cities are subjected, such tests as are described by the writer yield results of undoubted value. We quote: Effort has been made to test fairly the artificial stones now prominently before the public, and to compare them with the natural stones in general use. The result in his mind has been a full conviction that artificial stone will, ere long, be extensively used, and, to a considerable extent, take the place of natural stone. The artificial stones examined have been the American Building Block, made by the Middlesex Stone Brick Company; the Frear Stone, made by the Massachusetts Frear Artificial Stone Company; the Union (Sorel) Stone, made by the Union Stone Company; and the Coignet stone, made by the New York and Long Island Coignet Stone Company. A preliminary remark may be of advantage. Many object to artificial stone because it is artificial. A sufficient answer is, that very many of the most valuable materials of industry are artificial; *i. e.*, they are composed of native elements brought into new relations and forms by the labor of man, guided by knowledge, which is the result of accident or study. Among these are iron, in the forms in which it is ordinarily used, steel, glass, brick, leather, vulcanized india-rubber, etc., a list which might be indefinitely extended. Why, then, may not man, having the lime, alumina and silica, and other elements which enter into the composition of so many of the best natural stones, combine them in accordance with the laws of chemical affinity, and make a stone which shall have all the valuable qualities of a natural stone? This question has peculiar force when we think of that old artificial stone of Rome, which remains to this day as hard as flint, while the natural stones, of which it formed the mortar-bond, have in many instances been disintegrated and decayed.

The points as to which a comparison is desirable are:—

1. STRENGTH.

Most of the stones of either class, as well as hard bricks, have sufficient strength for any probable need. Buildings of brick have fallen, owing to the poor quality of the brick or of the mortar. The crushing strength of weak, red brick is from 500 to 800 lbs. to the square inch of surface; that of the best quality is about 4,400 lbs. Buildings of so-called artificial stone have

Beton-Colgnet Buildings, Clinton Avenue, Brooklyn. Erected in 1872.

also in some instances fallen. The case of the Howard University, built of the American building block, is well known. Samples taken from the fallen wall had a crushing strength of only 173 lbs. for samples four months old, to 443 lbs. for those twelve months old, much less than that of soft brick, while the strength of the Union (Sorel) stone and of the Coignet stone (both of them artificial) is from 5,000 to 10,000 lbs. to the square inch, that of the best marble being 8,950 lbs., and of Quincy granite, 15,300 lbs., and of brown stone, from 3,000 to 5,500 lbs.

2. PERMANENCY.

On this point we present an extract from a paper by J. H. Owens, M. A., a distinguished English architect, who, speaking of the use for building purposes of Portland cement concrete (which is really an artificial stone, crude indeed and roughly made), says: "Every other material used in building, except the hard granites and the most compact limestones, depreciate with time and exposure, and require an initial excess of material to be used, whereas Portland cement concrete is permanent and durable under all circumstances, and increases rapidly and enormously in strength, and continues to increase, but in a continually diminishing ratio, for as long as observations have, up to the present time, been made upon it." The Coignet stone, which, like the Portland cement concrete, is a hydrosilicate of lime and alumina, but far superior in the density and homogeneousness of its structure, resulting from the vastly superior conditions and methods of its manufacture, possesses the same characteristic, specimens more than a year old having shown, under hydrostatic pressure, a crushing strength of over 12,000 lbs.

3. RESISTANCE OF FROST.

This depends very much on the structure of the stone. Granite and marble are granular in structure, while brown stone is laminated, and liable, from the natural cleaving, to scale off, in consequence of alternate thawing and freezing. Artificial stone is frequently so made as to be liable to the same difficulty, a liability entirely obviated in the Coignet stone by the method of aggregating the particles patented by M. Coignet, producing a perfectly homogeneous stone, resembling in its structure the most compact marble, and without tendency to cleave in any particular direction. It is also, according to the testimony of Dr. Walz, analytical chemist of New York, who subjected specimens of it to very severe tests, "practically impervious to water."

4. RESISTANCE TO HIGH DEGREES OF HEAT AND ADAPTATION TO THE CONSTRUCTION OF FIRE-PROOF BUILDINGS.

In reference to this point the writer subjected samples of various natural and artificial stones to the following tests. Pieces of the different kinds were heated to redness and then allowed to gradually cool. Other pieces of each kind were heated to redness and immediately plunged into cold water. Quincy granite was in both cases disintegrated. White marble was much weakened in the first test, so as to be easily broken by the fingers; in the second it was rendered quite friable. Soapstone was, in either case, affected but very slightly, if at all. Brown stone (good specimens from Portland, Ct.) in both cases was disintegrated quite as much as the granite. Brown stone from Seneca, Md. (the most compact brown stone ever examined by the writer), in both tests appeared to be uninjured. Nova Scotia freestone was somewhat weakened, but endured both tests better than the other natural stones, except soapstone and Seneca brown stone. Of the artificial stones, the American building block (samples from a block made by the Middlesex Stone Brick Company, and more than two years old) was in both tests even more completely disintegrated than the granite. Frear stone (made in Worcester, and about eighteen months old) was affected rather more than the marble, becoming very brittle. The Union (Sorel) stone (two years old) was in the first test disintegrated as much as the granite; in the second test, when the heated piecer were plunged into the water, a chemical change was imme-

diately produced, indicated by a violent effervescence, and the stone crumbled into small grains. The Coignet stone endured both tests equally well with the soapstone and the Seneca brown stone, not apperaring to lose any of its strength. As to the result of the last-named stone, we quote again from Mr. Owens, who says of the Portland cement concrete (of which, as we have said, the Coignet stone is a cognate), that "it is the only fire-proof building material." Another sample of the Coignet stone, of inferior quality and coarser texture, was subjected to the same tests, with equal satisfactory results.

5. ADAPTATION TO ARCHITECTURAL ORNAMENTATION.

In this respect artificial stone has greatly the advantage of natural stone, as all forms of ornament, from the boldest to the most delicate, the plainest and the most elaborate, can be rendered in artificial stone at a much less price, the ratio of comparative cheapness increasing with the degree of ornamentation.

The Coignet stone is the result of experiments, conducted through several years, by Mons. F. Coignet, a civil engineer of Paris, who perfected and patented his process in 1856. In France there was at first great prejudice against it, and it was used very cautiously and in minor structures, but, after years of experience of its value, it received the unqualified approval of the architects and engineers of Paris, and the official sanction of the French Government, which have adopted it for many very expensive works and on an immense scale. General Q. A. Gillmore, of the United States Engineers, was sent to France to examine officially the structures of the Coignet stone and to ascertain its adaptability to government works. In his report, made to the War Department and published by its authority, he says: "Many interesting applications of this material were examined, of which it is not necessary to make any special mention, except that in combined stability, strength, beauty and cheapness, they far surpass the best results that could have been achieved by the use of any other materials, whether stone, brick, or wood. For warehouses, churches, and large buildings of every description, for foundations, abutments and massive walls of all kinds, for side malls, platforms and flagging, and for many other minor purposes, Coignet stone possesses not only great comparative cheapness, but all the essential merits of brick and stone, with respect to strength, hardness and durability, while for many purposes, within the province of the architect and engineer, it possesses advantages peculiar to itself, and not equally shared by other materials." This process has been in use for about three years in this country. The New York and Long Island Coignet Stone Company, having a large capital, extensive buildings and yards, and ample machinery and other facilities, are doing a very large and profitable business in New York City and Brooklyn.

From the "London Builder," November 30, 1867.

TO THE EDITOR:

SIR—I have lived many years in the county of Suffolk, where, from the scarcity of strong clay, this kind of wall was common, and most of the old walls are formed (though not with so strong a flux) in this manner, occasionally faced with split flints. One of the finest church towers of the kind, St. Peter's, Ipswich, has been erected nearly four hundred years, of concrete faced with split flint and stone dressings. The tower has an area of 140 square yards, and a height of 100 feet, as perfect and substantial now as when first built. This affords the strongest proof that can be required of the simplicity of those who talk about the instability of concrete erections, and the necessity of bonding them throughout. Clay in Suffolk being so scarce, the early builders, even so far back as the thirteenth and fourteenth centuries, turned their attention to this compound substance; the idea was roughly worked out, I admit, but true in principle; and in pulling down such buildings, the men have far more difficulty, and it takes an infi-

nitely longer time with pickaxes, than a dozen brick ones would. I have seen the bricks which have been imbedded in the concrete of these old buildings smashed to pieces before the concrete would give way. Some of the walls of the old Grammar School, Ipswich, three hundred years old, I saw pulled down myself. The men could not pick them down, but were obliged to mine with gunpowder before they could level them.

Putting aside the known great porosity of bricks, and, therefore, their great susceptibility to disintegration, and the necessity of some profit to the builder, which the high price of land almost prevents, I trust I have given proof of the advantage of such concrete erections.

THOS. C. EDGLEY.

Extracts from "Manufacturer and Builder," New York, 1872.

Page 229.—"The durability and healthfulness of structures of cement stone is greater than that of buildings of brick or sandstone, while, at the same time, they are considerably less expensive."

Page 265.—"In no case ought a builder be allowed to build stone or brick walls on the tops of iron columns. This habit is pernicious in the extreme."

"The intrinsic value of iron in buildings as a fire-proof material, is conspicuous only in roofs, floors, and shutters; but for inside frame-work, as now used, it adds terribly to the destruction of buildings in a fire."

From "Harper's Monthly Magazine," January, 1871.

CONCRETE FOR BUILDING PURPOSES.

Such of our readers as are unacquainted with the value and importance of a new concrete, invented by a French engineer—M. Coignet—and bearing his name, will probably be surprised to learn that, at a comparatively small cost, works of the greatest magnitude are now made, as well as those possessing the utmost durability. An elaborate report on this subject has lately been printed by the State Department among its series of reports on the Paris Exposition of 1867; and if no other service has been rendered in return for the expenditures made by the United States in connection with the Exposition, this one work alone would be more than an equivalent, in bringing to our notice so important a material. The process of preparing this concrete, or bèton-coignet, consists simply in mixing a large quantity of sand with a small quantity of hydraulic lime, to which has been added a minute portion of Portland cement. This mixture, slightly moistened with water, is subjected to an energetic trituration, with compression, so as to produce a pasty or pulverulent powder. This pasty powder is then thrown in thin layers into moulds, where it is agglomerated vigorously by the blows of a hammer, causing it to set almost instantaneously. In less than eight days the concrete becomes so hard as to allow of the removing of the centering from arches twelve feet in diameter—a thing which could not be properly done in the same time with the best masonry.

This new concrete is now applied in France to a great variety of subjects—palaces, private residences, churches, archways, reservoirs, sewers, water-pipes, etc.—all capable of being formed out of a single piece; of the greatest solidity; of perfectly smooth exterior, and susceptible of embellishment with every variety of adornment; impervious to water; secure against the action of frost; and all at an expense very appreciably less than that of ordinary masonry.

From the "Brooklyn Society Magazine," December, 1872.

AN IMPORTANT DISCOVERY.

In 1856 a Parisian *savant*, named Coignet, discovered an artificial stone, which, after an examination by the French Government, was pronounced equal in appearance, strength and durability, to the natural stone, and invulnerable to the effects of heat, dampness or frost. They utilized it by building forty miles of the famous sewers of Paris. Sewers of this conglomerate have also been laid in Odessa, Russia, which have stood the tests of years; docks at Bordeaux; pavement at Lyons, and the blocks of the Suez Canal and the light-house at its entrance, which is one hundred and eighty feet high and rests upon a solid block, containing four hundred cubic yards of the same material. In our city it has come into large use in the numerous buildings already completed or in process of erection; in the Cleftridge Span between the Lake and the Refectory in Prospect Park; in the arches, columns, and traceries of the great Roman Catholic Cathedral in our neighboring city. Our National Government sent Gen. Gillmore abroad to officially investigate this discovery. His report says that after a careful examination he finds the "Coignet stone adapted and adequate to the demands of every department of engineering, architecture and sculpture, being suitable alike for breakwaters, lighthouses, aqueducts, sewers, reservoirs, residences, monuments, churches, flagging, statuary and other works requiring elaborate ornamentation." The Government is now using it. Our city has the honor of containing the first factory of this kind in America, at the corner of Third avenue and Third street, South Brooklyn. The Company is erecting on their grounds an elegant three-storied office of this stone, which will be an ornament to the city, and will afford the curious an opportunity of witnessing its beauty. As our space is limited, we must content ourselves with allusion merely to this important discovery; in a subsequent number we may present our readers with an engraving of some local celebrity, which is built of this stone.

The walls of the fortress of Ciudad Rodrigo, in Spain, are of concrete. The marks of the boards, which retained the semi-fluid matter in their construction, are everywhere perfectly visible; and besides sand and gravel, there are everywhere large quantities of round boulder stones in the wall, from four to six inches in diameter, procured from the ground around the city, which is everywhere covered with them.—*Major-Gen. Sir W. Reid, R. E.*

From the "N. Y. Trade Reporter," December 13, 1873.

The plaza at the entrance of the new fountain at Prospect Park is now very nearly complete. The dome for this fountain, of which Mr. Calvert Vaux is the architect, is made by the New York and Long Island Coignet Stone Company, of Brooklyn, and is of béton-coignet—an artificial stone of great strength and beauty. The design and workmanship is said to be finer than any work of similar character in the United States. The whole dome is elaborately ornamented with appropriate designs; is so carefully put together, and so ingeniously constructed, that no joints are visible and the whole mass is firmly bound together.

The open spaces on the dome are to be covered with colored glass. Inside of this gas jets, lighted by electricity, will during the night give a most beautiful effect. The water cone plays from the dome and falls back into the fountain through a hundred jets.

From "The Industrial Monthly," January, 1872.

The greatest crushing strength for various natural and artificial stones are given in General Gillmore's work, as follows:

	Material.	*Crushing Weight per Square Inch in Pounds.*
Natural.	Granite, Patapsco	5,340
	" Quincy	15,300
	Marble, Montgomery County, Penn	8,950
	Sandstone, strong	5,500
	" Connecticut	3,319
Artificial.	Brick, first quality hard	4,368
	Béton-coignet	7,500
	Concrete, Ransome's	6,720

From "The Hardware Circular," June 1, 1871.

The future material for houses and engineering structures in this country is evidently artificial stone. The wages of stone-cutters, and the high price of labor generally, must determine this question. It may be well, therefore, to consider some of the inventions that have been made within the last few years, looking to a solution of the important problem. Artificial stone can now be made in Europe of undoubted strength and durability, and cheaper and better than hewn stone. We understand that in this country satisfactory experiments have been made, and there is every probability of a general acceptance of this material, as soon as the public are made aware of all the facts of the case.

We do not propose to enter into a history of the mortars, cements, concretes, and the like, that have been made since the time of the Romans, but to speak of some of the modern experiments that have attracted the most attention from engineers. Perhaps the best known cement or artificial stone is the béton-coignet. We have had occasion to witness the preparation of this celebrated building material in Paris, and have examined some of the constructions in that city and elsewhere, and can therefore speak from personal observation. Béton was introduced into France about thirteen years ago, by M. Coignet. There was much opposition to it at first, and it was only cautiously tried on construction of little importance.

By progressive experiments and changes of constituents, M. Coignet finally hit upon a mixture that was able to resist all extremes of weather, and to withstand the severest tests that could be applied to it. It is of this invention that we propose to speak. Béton-coignet is an artificial stone, capable of being used in blocks or continuous masses, for foundations, walls above and below ground, sewers, water pipes, floors, pillars, arches, embankments, aqueducts, reservoirs, cisterns, and the entire walls of buildings, bridges, tunnels, flagging, and, in fact, all structures ordinarily made of brick or stone. It is a solid stone. Fine specimens of statuary have been made of the well-mixed material. The arches of the basement to the Paris Exhibition of 1867, which constituted a perfect labyrinth, were of this material. In no other way could these vast constructions have been completed in time for the Exhibition. They were visited by thousands of persons interested in the subject, and did more to dispel doubts and satisfy engineers than any previous works constructed of this material. The work was done with amazing rapidity, as the centering was often within ten hours after the béton was got in place, and the passages were ready for service in four or five days after their completion The embankment at the Trocadero in Paris, for a quarter of a mile, is supported by a wall of béton, forty

feet high, and one of the bridges over the Seine is built entirely of the same material. In Egypt, the very sands which threatened to destroy the Suez Canal have been appropriated to the manufacture of sea-walls, embankments, light-houses, and vast constructions, by this system of coignet.

In view of all these facts, it is not surprising that so much attention should be bestowed on artificial stone in this country.

From the American "Commercial Times," March 7, 1874.

BETON-COIGNET.

In a scientific treatise upon the subject of stone, the requisite features of that material for building purposes are thus concisely given, and we quote them merely because they can not be more plainly presented in words:

"A good building stone ought to possess great powers of resistance against crushing and breaking weights; it should be of even grain, and capable of furnishing large blocks; its constituent parts should not be susceptible of decomposition by the action of the atmosphere, or by their mutual reaction upon one another; it should neither absorb either water or vapor, except to a certain extent; and, as far as possible, it should be of *an homogeneous nature.*"

While these simple facts are known both in their theoretical and practical lights everywhere, it is not by any means so generally known that their entire combination is mainly or most effectually found in manufactured stone, or an agglomerated mass of earthy matter, composed for the most part of hydro-silicate of lime and alumina, combined in solid body as rock or stone by a peculiar process, which a few years ago was revived in France, by one M. Coignet, after it had for centuries been numbered among the "lost arts." This material, now being so generally adopted for building purposes, both for base and body of all kinds of structures, is known as béton-coignet. Its manufacture in the United States is of a comparatively recent date, and the works of the producers are in Brooklyn, situate on Third avenue, between Third and Sixth streets, covering an area of five acres.

This béton, or concreted stone, is capable of resisting a hydrostatic pressure of 12,000 lbs. per cubic inch, and with age improves both in solidity and weight. It is made to imitate almost any variety of building or decorative stone, and to any one unacquainted with it would be, in almost every instance of first experience, mistaken for the natural stone, on account of its manifest firmness and density. The writer was shown a dozen or more different pieces in comparison with a corresponding number of natural stone, and, in pronouncing opinion as to the artificial or natural, is not ashamed to confess that he was wrong in every instance, not being either a geologist, a mineralogist, or a manufacturer of stone; but he is satisfied that 99 men out of every hundred would be similarly deceived, and hit upon a correct opinion by accidental rather than by sound judgment—provided he did not know what we propose to tell,—that the béton is finer grained, weightier and far more difficult to crush under pressure or break by a heavy blow than the natural stone of which it may be made in imitation; and, being a solid conglomeration, it is firmer than rock by virtue of its essential unlamination. It is a pressed substance, and so moulded into any desired size or form—a given pattern made may be followed by as many more as desired in less than a twelfth of the time required to do the same work upon natural stone—a fact in itself, aside from the superior firmness and durability of the material, sufficient to commend it to the best consideration of architects and builders, inasmuch as its cost is so much less than the hewn article. Moreover, its established characteristics of imperviousness to water, or dampness of any kind, due to its base composition having been thoroughly burnt and baked before agglomeration, and its unequaled power of resistance to fire, not breaking or even cracking under the severest tests, further combine to make it the most desirable building and decor-

ative stone that can be considered in the plans and estimates of architects or employed by builders. It certainly combines all the features laid down in our text as requisite in the best building stone, and to a much fuller degree than either granite, marble, freestone or brown stone.

Notwithstanding the comparatively recent production of béton-coignet in the United States —dating, if we mistake not, only since 1866—it is now a material hardly unknown and seldom unrecommended by any intelligent architect in the country, and is therefore rapidly becoming known by the masses through its existence before their eyes daily in and about structures such as, in New York and Brooklyn, the Worth Monument, Broadway and Fifth avenue; the Roman Catholic Cathedral, Fifth avenue and Fiftieth street; the magnificent Cleftridge Span penetrating Breeze Hill in Prospect Park, and the new circular fountain at the entrance thereto—which, by the way, it may be remarked, is 113 feet in diameter and said to be the handsomest fountain in the United States—besides many private residences, etc. At the recommendation of Gen. Q. A. Gillmore, it has been used in the construction of the casemates, sally-ports, floors etc., of Fort Wadsworth, Staten Island. The Company making the stone have recently erected at the corner of Third avenue and Third street, Brooklyn, a handsome building for themselves for use as their office, which will give the curious or skeptical upon the subject a very fair idea of the superlative adaptability of the material to such purposes.

In Europe béton-coignet has been in use during the last eighteen years, where it has been called into service to a very great extent for sewerage, the building of docks, breakwaters, span bridges, monumental structures, aqueducts, light-houses, reservoirs, etc., not to speak of its exceeding popularity as a building stone in the erection of churches and private residences—in fact, of any description of stone-work requiring that homogeneity in the material from which it is constructed, as our text implies, as the requisite features of the best building stone.

From the "American Progress," Feb., 1874.

THE BETON-COIGNET STONE.

Antiquarians tell us of the artificial stone of old Rome, which remains to this day as hard as flint, while the natural stones, of which it formed the mortar-bond, have in many instances disintegrated and decayed. Some years since, a Frenchman named Coignet set about the discovery of this "lost art" of making a building stone which should be more durable under the varied conditions of climate and temperature than the natural stones now in use, and which should be readily moulded into useful and beautiful forms. The result of his experiments is the "béton-coignet," which seems to meet, to a wonderful degree, all the requirements of a perfect building stone. When tested by a hydrostatic press, it resists a crushing strain of 8,000 to 12,000 pounds per cubic inch, while that of the best brick is 4,400 pounds; marble, 8,950 pounds; and Quincy granite, 15,300 pounds. The Coignet stone—which, like the Portland cement concrete, is a hydrosilicate of lime and alumina, but far superior in the density and homogeneousness of its structure, resulting from the vastly superior conditions and methods of its manufacture—possesses the characteristic of increasing in strength with age and exposure.

The capacity of any building stone to resist frost depends very much on the structure of the stone. Granite and marble are granular in structure, while brown stone is laminated, and liable, from the natural cleavage, to scale off, in consequence of alternate thawing and freezing. This liability is entirely obviated in the Coignet stone by the method of aggregating the particles patented, by M. Coignet, producing a perfectly homogeneous stone without tendency to cleave in any particular direction, and also entirely impervious to water.

The recent great fires, affecting not only those whose buildings have been destroyed, but the whole commercial interests of our country, have called the attention of our builders to the

adaptation of different materials to the construction of fire-proof buildings. The terrible explosion of granite when subjected to intense heat, and the crumbling of marble, becoming converted into lime, have diminished our confidence in what were supposed to be our strongest and most enduring materials. In reference to this point, samples of various natural and artificial stones have been subjected to the following tests: Pieces of the different kinds were heated to redness and then allowed to gradually cool. Other pieces of each kind were heated to redness and immediately plunged into cold water. Quincy granite was in both cases disintegrated. White marble was much weakened in the first test, so as to be easily broken by the fingers; in the second it was rendered quite friable. Soapstone was, in either case, affected but very slightly, if at all. Brown stone (good specimens from Portland, Ct.) in both cases was disintegrated quite as much as the granite. Of béton-coignet, it is the *only* fire-proof building material known, as it neither explodes like granite, calcines like marble, nor warps and twists like the iron structures, but retains its integrity through the severest tests. In addition to this invaluable quality, the non-conducting character of the agglomerate, and the air-spaces of the blocks, make the wall a protection which resists the passage of heat to any combustible material beyond it, and thus effectually checks the progress of a conflagration in adjacent buildings. The prejudices against *artificial* stone, which has been fostered by a succession of failures, can be easily met by pointing to the artificial fire-brick, which resists the effects of heat infinitely better than any natural stone.

Its peculiar character adapts it to the demands of every department of engineering, architecture and sculpture, from the boldest edifices to the most delicate works of art. Palaces, private residences, churches, archways, reservoirs, sewers, water pipes, etc., are capable of being formed in a single piece of the greatest solidity, impervious to water, secure against the action of fire and frost, and capable of every variety of embellishment.

From the "Brooklyn Gazette," October 7, 1872.

A Journal Devoted to the Interests of the Exposition and Industrial Fair of Kings County.

THE COIGNET STONE COMPANY.

One of the most conspicuous and at the same time most interesting features of the Exposition, is the artificial building stone made by the New York and Long Island Coignet Stone Company. The idea of artificial stone suggests, at first thought, an article that may resemble stone, but which can not by any possibility possess the same qualities of hardness, weight, and strength. The Coignet stone has been subjected to all these and many other tests known to builders and scientific men, and stands without a rival, one of the most complete and useful of modern inventions. The beautiful samples of it now on exhibition, comprising the coping around the fountain, the receptacle for a burial casket, the finely moulded statuary, the elegant architectural pieces for buildings, the columns, and other interesting articles, impress the visitor most profoundly with the various uses to which it may be subjected. These samples, in weight, are similar to granite. It is claimed that they will bear the same strain, and can be used not only for all the purposes of the best building stone, but many others.

Lying upon the floor with these manufactured articles, is a square, homely stone, bearing some quaint carvings, from Luxor, Egypt. It is of the same material found in these very ancient cities, whose palaces were broken into ruins and fragments a score of centuries ago. It is supposed to be 3,000 years old. Portions of this ancient stone, or others precisely similar to it, have been subjected to chemical analysis, and it is found to possess precisely the same constituent elements, and in the same proportion as the Coignet stone. That it was made in a similar way, though, perhaps, with ruder and more laborious process, there can scarcely be a doubt. The fact is corroborated to a certain extent by history. To suppose that those immense blocks of stone found

in Egypt, from twenty-five to one hundred feet in length, and of immense thickness, were hewn out of rock and reared to upright positions, is quite beyond probability. They were unquestionably made from clay, and when first made were as plastic as the mortar now used in laying brick.

Elsewhere, in the columns of this paper, an interesting account is given of the Company's works in this city, the process of manufacture, the localities where it has been used for building purposes, and a synopsis of the very exhaustive and commendatory report given of it by the United States Commissioners at the Paris Exposition. Its adaptability far exceeds that of any other stone of equal value. If desired, a mile of sidewalk could be laid in one continuous stone, as well as six feet. The entire floor of the Rink could be covered with a stone of any desired thickness, which would constantly harden, and within a few hours could be traveled upon, and within a few days would not yield to the weight of a train of loaded freight cars. A flight of steps to a dwelling could be made one piece, railing and all.

The location, in this city, of so vast a business enterprise as this has already become, is a fact in which Brooklyn may well take pride, and the vigor which it will impart to all collateral industries in the future, will give it a position in which thousands of citizens should take a lively interest and satisfaction. It seems almost superfluous to state that the Company is doing a very large business, so quickly does its work impress the builder with satisfactory answers to his questions as to beauty, durability, and cheapness.

Treatise on Limes and Mortars. By George C. Burnell, C. E. 1869.

There has been a considerable amount of interest attached of late to the attempts made by M. Coignet to introduce what he calls béton aggloméré, and the results attained are sufficiently remarkable to merit our attention on the present occasion. M. Coignet has executed many thousand francs' worth of work in the béton aggloméré in the sewers of Paris; he has built entirely in that material the church of Vesinet, near Paris, and he has applied it to the execution of railway and common bridges of fifty feet span, at least; so that it can no longer be considered that the experiment is upon trial. In fact, the results that have been attained at the Dover, Alderney, Cherbourg, Marseilles, Algiers, etc., works, had long since proved that concrete was susceptible of being used in building operations like any ordinary stone, and all that M. Coignet has done in this case has been to demonstrate the fact in a striking manner.

M. Coignet's system consists in the employment of every description of lime in the preparation of the béton, which he takes every precaution to have slacked with just the proper quantity of water to insure the hydration of the lime, and then carefully to triturate the mass, and to compress the ingredients in moulds by a system of ramming. The best materials that are thus produced are composed of a mixture of the slow-setting artificial cements, with a good hydraulic lime and a proper proportion of sand; and great skill is required in so apportioning the lime and cement, that the powers of the resulting mass should present everywhere the same powers of resistance to the weights or forces they may have to resist. Of course, there can be no difficulty in varying the proportions of the lime and cement to produce this result, though M. Coignet neglected this precaution in the building of Vesinet church; nor can there be any difficulty in observing the precautions that are required to provide for the contraction and expansion of the masonry in a monolithic bridge, such as that gentleman has executed. Well and judiciously used, there can be no reason why Coignet's agglomerated béton should not be employed for the execution of all descriptions of masonry. The admirable manner in which the works of concrete executed by Roman and mediæval architects have stood the effects of time, must always excite our surprise that the use of that material should have been so long neglected, and the building arts deprived of the advantages it offers for the execution of monolithic structures, or those made by the agglomeration of small materials.

From the New York "World," March 9, 1873.

THE CLEFTRIDGE SPAN.

The Cleftridge Span, of which we give accurate illustration, is in Prospect Park, Brooklyn. It penetrates Breeze Hill, and enables visitors, turning from the main entrance, to reach the concert ground and lake shore on foot, at an easy grade, by a protected line of approach. This archway was at first designed to be formed of granite and brick, but before any contracts were made, the Long Island Béton-Coignet Company offered to make the whole of their patented artificial stone. The architect, Mr. Calvert Vaux, agreed to this, and the experiment has proved satisfactory. The principal advantage of this material for decorative purposes lies in the facilities it offers for the introduction of ornamental detail, because after a design for recurring ornament is once well modeled and prepared for carving, it can be repeated again and again with ease and precision. In the architectural treatment of archways for park purposes, the most serious difficulty lies in the arrangement for the soffit or ceiling, the surface of which is always so large that its elaboration in brick, stone, or wood is only admissible in very prominent situations on account of the cost involved. Under these circumstances the soffit of the arch becomes the key-note of the design, and in the Cleftridge Span this part of the work has been made over its whole surface of a very rich and elaborate pattern. The archway is now completed, and the result is sufficient to show that it must prove a valuable addition to the decorative resources of the architect. The manufactured stone called béton-coignet, a report upon which was published by the State Department in 1867, is applied in France to palaces, archways, reservoirs, sewers, water-pipes, etc. All these can be made practically in one piece of the greatest solidity, impervious to water, secure against the action of fire and frost, and capable of every variety of embellishment. According to General Q. A. Gillmore and the other commissioners sent by our Government to the Paris Exposition, it is now seventeen years since this stone was first introduced into France. There are forty miles of sewers of this material in Paris, built during five successive inundations of the Seine, but completed in perfect order. There are also sewers in Odessa, Russia, of béton-coignet, which have withstood the test of years; docks at Bordeaux, pavement at Lyons, the foundations and galleries at the Paris Exposition; the Government cavalry stable floors, the grooves of which remain perfect after years of service; the barracks of Notre Dame; the embankment of the Avenue de l'Empereur; the great railroad bridge between Lyons and Marseilles; the structures of the Northern Railway and the masonry of the Gardens of Rentilly.

The blocks of the Suez Canal and the light-house at its entrance are of this material, the latter being 180 feet high, and resting upon a solid block containing 400 cubic yards of the agglomerate. In this country the following specimens of this work are to be seen already: The pavement around the Worth Monument, Broadway and Fifth avenue; the receiving tomb at the cemetery of the Evergreens, which, when finished, will be a massive monolith holding 500 bodies in its catacombs; forty-seven buildings, mostly imitation of brown and sand stone, in Brooklyn, finished and in course of erection; the arches, columns and traceries of the Roman Catholic Cathedral, Fifth avenue and Fiftieth street; the Plaza of Woodsburg Pavilion at Rockaway; some buildings at Ward's Island; and the casemates, sally-ports, floors, etc., of Fort Wadsworth on Staten Island, the Government having adopted it at General Gillmore's suggestion. The béton-coignet is said to be the product of an effort to revive one of the "lost arts." The elements of the stone to be imitated are first ground down and mixed by machinery and then moulded. The moulds, after being gradually filled by a scientific process which entirely excludes the air, are immediately removed, and the stone, which is ready for transportation in a few days, continues to increase in weight and density.

From the "Scientific American," April 11, 1874.

BETON-COIGNET ARTIFICIAL STONE FOR ORNAMENTAL ARCHITECTURE.

Some seventeen years ago, M. Coignet introduced his béton stone into France. Although at first encountering popular prejudice, the material speedily made its way, through its intrinsic merit, into favor, and finally, after being experimented upon for a period of two years, was adopted by the French government in the construction of many important edifices and structures. Forty miles of sewers in Paris, the immense aqueduct of Le Vanne, the arches of which cross the sandy valley of Fontainebleau for a distance of thirty-one miles, the supporting arches of the Exposition building, the docks at Bordeaux, and in various other prominent engineering works, the béton-coignet has been entirely employed; and also in Egypt the material has been used for light-houses, and in forming the massive blocks used in the building of the Suez canal. In a large number of private and public edifices in the vicinity of this city, recently erected, this stone has been applied. Prominent instances among these are the arches, columns and traceries of the great Roman Catholic Cathedral, now in progress on the corner of Fifth avenue and Fiftieth street, and in the various architectural ornamentations of Prospect Park in Brooklyn. Our engraving represents Cleftridge Span, in the latter grand pleasure ground, a very beautiful arch, highly decorated, and the design of Mr. Calvert Vaux. This structure it was at first intended to build of granite and brick, but subsequently it was determined to make the whole of artificial stone, the material being especially advantageous for decorative purposes, as it offers great facilities for the reproduction of ornamental detail. A design once well modeled and prepared for carving, can readily be repeated.

A large new manufactory of béton-coignet has been established by the New York and Long Island Coignet Stone Company; it is on Third avenue, between Third and Sixth streets, in Brooklyn, N. Y. The works are very extensive, covering an area of five acres, and are capable, we understand, of turning out fronts of ten ordinary houses per day, besides a large quantity of fine ornamental work, giving constant employment to some one hundred hands. The process of manufacturing consists in first grinding down the constituent elements of the stone to be imitated, and mixing them by machinery until they reach a plastic state. The moulds are then filled by a peculiar process which entirely excludes the air, and are immediately removed. The stone, within a few days, is ready for transportation, and continues to increase in density.

The béton is impervious to water; and so far as experience proves, withstands the effect of frost or extreme northern climates, and will withstand a crushing pressure of about four tons to the square inch. Structures composed of it are much lighter than those of natural stone, while the strength is equal, if not, in many instances, greater. A cubic foot of the material weighs about one hundred and forty-six pounds. Walls made of it present a homogeneous mass, and are not liable to the accidents common to brick and mortar structures.

We learn that, since the failure of both granite and marble in the great fires of Chicago and Boston, tests have been made as to the capability of béton-coignet to resist intense heat, and the results show that it neither explodes like granite, calcines like marble, nor warps and twists like iron structures. It is, besides, a non-conductor of heat to no small extent, and therefore tends to check the passage of conflagrations from building to building.

General Gillmore, of the U. S. Engineers, some time since visited Europe for the express purpose of inspecting the structures made from this stone, and on his recommendation the Government has adopted it for use in the construction of the casemates, sally-ports, floors, and other portions of Fort Wadsworth, on Staten Island. It would be difficult, we imagine, to limit the employments for which the material appears eminently suitable. As illustrated by Cleftridge Span, its peculiar character adapts it to the imitation of the most elaborate tracing and sculpture in the rarest stones; for, by admixture of pigments, tiles of any color may be accurately reproduced. The cost of manufacturing is said to be about half that of natural stone when cut.

From the "Brooklyn Eagle," June 11, 1873.

BUSINESS STRUCTURES.

One of the most elegant business structures in the city is the new office of the New York and Long Island Coignet Stone Company, at the corner of Third street and Third avenue. It is 25 x 40 feet. The style of the exterior is very peculiar, combining excellent specimens of a variety of architectural orders. It is built entirely of the Coignet artificial granite shaded stone. It is two stories and a basement. The lofty parapet adds to it the effect of almost a third story. The whole structure is a beautiful evidence of the work that can be turned out by that Company, who are determined to have a standing specimen of how it will endure all extremes of heat and cold, frost, snow and rain peculiar to our variable climate. The smallest detail in the masonry is remarkably well defined, and every design stands out in bold, striking relief. The edifice in the most select neighborhood would be a very attractive one, but located where it is, having nothing but wooden sheds and fences to contrast with it, stands out proudly and challenges the attention of all wayfarers. It is not improbable that another building akin to it, of the same material and design, will, before long, be erected in the same locality for business purposes. As soon as the interior shall be finished it will be occupied for the business purposes of the Company. Wm. Field & Son are the architects; D. B. & A. Rutan, the masons; Riley Cocroft, stone setter; Henry Case, who built the frame work of the Fulton ferry-house, is the carpenter.

THE PROSPECT PARK FOUNTAIN.

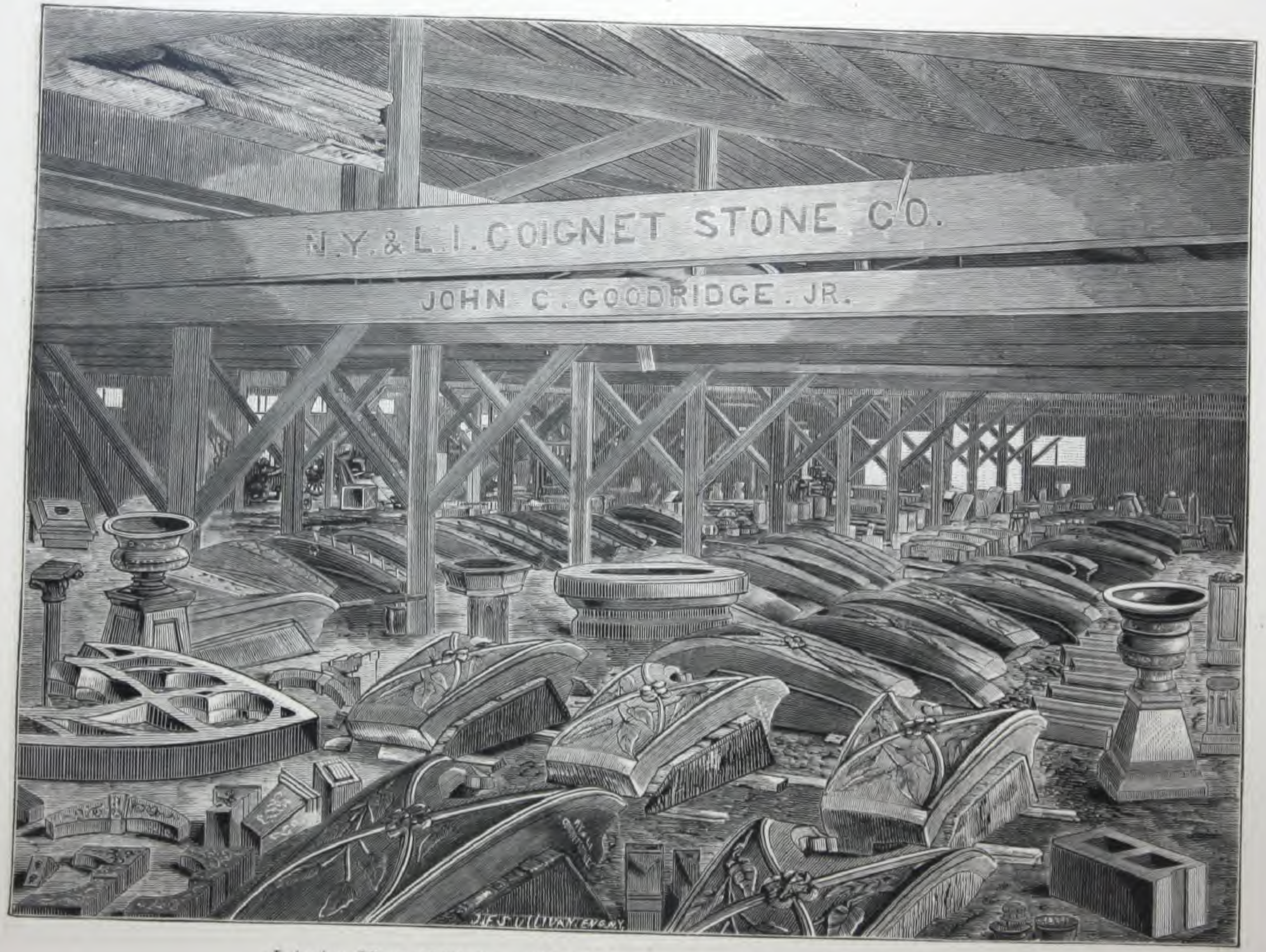
Visitors to Prospect Park have undoubtedly admired the fountain at the Plaza, near the Lincoln statue, with its elaborate and costly railing, but there is greater beauty in store for the people. The fountain, which dashes off its spray upon the currents so refreshingly at present, is only temporary. In the centre of the basin, on the foundation already laid, is to be a grand dome one hundred and thirteen feet in circumference. It will be constructed of the Coignet artificial stone. The base of the dome will be a series of gothic arches, up the sides of which are defined beautifully trailing vine leaves, up to where it meets a ring of smaller circumference, from whose sides shall issue jets in such arrangement as to form one entire sheet of water, which shall fall into the basin, leaving the openings of the gothic arches untouched. And from the summit will issue the usual fountain. The area beneath the whole dome will be lighted with gas, an arrangement which in the evening will produce an effect entirely new to Brooklynites—an effect which will increase the admiration which visitors already express in the most enthusiastic manner. The design is by Mr. Vaux, the celebrated landscape architect, who has contributed so many fine and pleasing effects to the Park.

MISCELLANEOUS.

The Coignet Stone Company's material is already in edifices where it will be thoroughly tested. One of the latest works accomplished with the aid of this artificial stone is the new receiving vault in the Evergreens Cemetery, with a capacity for holding five hundred bodies. The inner area measures fifty feet by twenty-six feet; height of main arch twenty feet, and the vestibule eight by eight feet. The Company is still supplying stone for the great cathedral in Fifth Avenue, New York. It made the trimmings for several churches in outside towns; for a house in Plainfield, New Jersey, and the Presbyterian church and chapel in Rondout, New York.

THE COIGNET GRANITE BLOCK OF FLATS.

The most remarkable looking block in the city is that which graces the junction of Atlantic and Flatbush avenues. It is in the form of a triangle, and consists of thirty buildings. The front is of the beautiful artificial granite stone manufactured by the New York



Interior View of Factory, Third Avenue, near Third Street, Brooklyn.

and Long Island Coignet Stone Company. Of the thirty houses, twenty-six have 20 feet fronts, and four have 25 feet fronts. The height is four stories, including stores. The flats on the three upper stories have each four apartments, with the modern improvements, and abundant closet room. For small, respectable families, an opportunity seems to be offered here. The external appearance of the block is rather attractive. The cornices, window sills, and parapets are all so well defined, and the complexion of the stone is so clear, that we lose sight of the monotony which would have marred the effect if brown stone had been used. The proprietor is Mr. Vreeland.

From the "Brooklyn Daily Eagle," August 29, 1873.

The Works and Grounds of the New York and Long Island Coignet Stone Company—The Brooklyn Stone an Improvement upon that of the Inventor—Business Done by the Company—The Grand Fountain at Prospect Park—A Thing of Magnificence and Beauty—Scientific Examination and Test of the Coignet and other Artificial Stones.

The New York and Long Island Coignet Stone Company, whose manufacturing establishment is in this city, located on Third avenue, and occupying the whole space of five acres between Third and Fourth streets, including the advantage of the Fourth street basin or branch of the Gowanus Canal, and extending to the canal, is an enterprise the nature of which commends it to the consideration of all who study building materials in regard to finer development of taste, durability and economy in the expenditure of money. It is hardly necessary to consider the merits of the Coignet stone for the benefit of men engaged in building enterprises, such as architects and contractors, for that class of our citizens appear to be already in possession of many important facts as to its many advantages; for, while they do not generally adopt it, or even recommend it, they have (many of them at least) confidence in the merits claimed for it, but in the absence of scientific knowledge, are patiently awaiting the results of the experiments already made by builders who have used it in various ways upon structures of different kinds in this city. Meanwhile the process of manufacturing the artificial stone goes on, mostly to supply new buildings of churches and private residences in country towns within easy reach of New York, locations where the test will be of great value on account of their exposed positions.

The Company, which appears to have all the anxiety for success that might be expected in an enterprise involving so vast an outlay of capital, are nevertheless not impatient. Their operations being based upon thorough scientific inquiry and a sound practical knowledge of the powers of endurance of the artificial stone, they are in no way uneasy as to what the ultimate result must be. Their greatest anxiety is in regard to proper and ample preparations for the demands to be made upon their resources in the near future.

In Europe, before the stone had reached the perfection of that which is manufactured here, that made under the original Coignet process was adopted for many of the most important purposes in public buildings, including light-houses, sewers, aqueducts, bridges, syphons, tunnels, etc. From a report made by the United States Commissioners to the Paris Exposition of 1867, it appears that béton-coignet had been found admirably adapted for marine structures. The Suez Canal, the docks of Boulogne, and numberless structures of this kind, bear witness to its strength and utility. It should be known that the New York and Long Island Coignet Stone Company have not rested in content in using merely the Coignet process. By persistent experiments and tests they have so far advanced from the original process as to obtain from the inventors in Europe the acknowledgment that the Company here is making a stone greatly superior to any that has been furnished in Europe. While the experiments have been in progress, and new processes have been adopted in the production of this perfected Coignet stone, the work of supplying orders for the new cathedral in Fifth avenue, New York, and churches and residences out of town, as well as for buildings in different parts of Brooklyn, has been steadily going on.

AN EXHIBIT OF BUSINESS.

The business done by the Company on the Gowanus Canal alone furnishes a partial indication of what has been done in the past year. The materials received by canal, at the factory, from July 1, 1872, to July 1, 1873, were as follows: 40 cargoes of sand; 2,500 tons sundry materials; 8,800 barrels Portland cement; and, during the same time, 765 building pieces of Coignet stone were shipped. This account does not, of course, include the vast business done by means of trucks and carts.

THE NEW FOUNTAIN AT PROSPECT PARK.

The stone for the great fountain at the Plaza at Prospect Park, near to the statue of Lincoln, is finished, and is lying in the yard awaiting removal to the place of construction. The present temporary fountain will soon be removed, and the new and magnificent structure of Coignet stone will take its place. As was previously set forth in the *Eagle*, the new fountain, which will be the most splendid architectural display of the kind in the country, will be erected upon the present ample foundation in the centre of the basin. It will constitute a grand dome one hundred and thirteen feet in circumference. At the base will be a series of Gothic arches, up the sides of which are defined, in exquisite taste and workmanship, beautifully trailing vine leaves, up to where the arches rest, as it were, upon a ring of smaller circumference, from whose sides shall issue jets, so arranged as to form one entire sheet of water, which shall bend itself gracefully over the arches and fall into the basin without a drop falling upon the arches. From the summit of the superstructure will issue the usual fountain, unless the plan may have been changed. Such will be the arrangement of this fine structure, that the space beneath the dome and inside the arches at the base will be furnished with gas fixtures, providing for the lighting of the fountain for the delectation and admiration of visitors to the Park. Citizens may anticipate this piece of ornamentation as being creditable to the taste of the architect, Mr. Vaux, to the spirit of the Commissioners, and to the capacity for fine work of the Coignet Stone Company.

COIGNET PATENTS.

The following patents have been granted François Coignet, in France, at various times since 1856. In the United States as dated below:

Patent No. 88,545.

Dated April 6, 1869.

To all whom it may concern:

Be it known that I, FRANCOIS COIGNET, of the city of Paris, in the department of the Seine, and empire of France, have invented certain Improvements in the Manufacture of Artificial Stones; and I do hereby declare that the following is a full and exact description thereof, which will enable others skilled in the art to make and perform the same, without further experiments and invention.

The nature of this invention consists in a special mode of manipulation, whereby by the use of hydraulic lime, of sand, and, in some cases, the addition of a small quantity of hydraulic cement, artificial stones, much harder than any artificial stones ever made from similar materials, can be uniformly manufactured, my new artificial stones resisting perfectly the effects of frost, of currents of water, the infiltration of sea-water, the action of alkaline and neutral salts, and the friction of wheels.

After repeated experiments, I have found that in order to obtain uniformly good artificial stone with sand, hydraulic lime, and hydraulic cement, it was necessary, first, to regulate in a systematic manner the amount of water employed in the manufacture thereof; second, to obtain, with a minimum quantity of water, the lime or cement in a state of plastic or viscous paste; third, to have each grain of sand entirely lubricated, and coated over with a thin stratum of this viscous paste; and fourth, to bring each and every grain of sand in close proximity with one another in a more thorough and effectual manner than is possible in any of the present known modes of manufacture of artificial stones.

To obtain these results, I proceed as follows:

DESCRIPTION OF PROCESS.

Preparation of the Lime.

The lime I prefer to employ is the kind known as hydraulic lime, as so denominated in "Totten on Mortars," 1838, page 2.

I have found it impossible to obtain a lime-paste of the proper quality for my purpose by the ordinary methods used in making mortars, for, if we take air-slaked lime, and add to it the necessary amount of water (about fifty per cent. in bulk), to obtain a paste, it would contain too much water for my purpose. If, on the contrary, we reduce the quantity of water, by using quick-lime and moist sand, or slaked lime and moist sand or dry sand, we obtain, instead of a paste, a moist powder of lime, which remains, in the subsequent treatment, in the interstices of the stone in an inert manner, and is totally unfit for the purpose.

To prepare the lime, I take, of air-slaked lime, one hundred by measure, and of water, from thirty to forty by measure. This I introduce into a suitable mill, acting by compression and friction, and subject the mixture to a thorough trituration, until the result is, a paste which is perfectly plastic, viscous, sticky, and quite characteristic.

Preparation of the Sand.

Although any and every sand can be employed in the manufacture of artificial stones, yet, when it is desired to obtain special results, and a maximum of hardness, it is necessary to employ none but selected or washed sand.

The sand should be deprived of moisture, and for that purpose may be dried by the action of the sun or the application of artificial heat. When it becomes desirable to apply this artificial heat, my plan is to place the sand in suitable chambers, and to drive through it a current of heated air, but any mode of drying the sand, which can accomplish the result desired, may be employed instead.

Trituration.

The lime-paste and sand, being mixed in the desired proportions (see further), are introduced into a powerful mill, in which the mixture is triturated in an energetic manner, and until, without the introduction of a further quantity of water, the paste will present the desired degree of homogeneity and plasticity.

When, for special purposes, it is desirable to introduce in the mixture a certain quantity of hydraulic cement, this has to be done during the process of trituration, and the desired quantity of water, regulated by the quantity and nature of the cement employed, has to be introduced at or about the same time, so that, after proper trituration, the whole material will present the appearance of a short paste, or pasty powder, which is quite characteristic of my process of manipulation.

The following proportions I generally employ for divers purposes, according to circumstances and quality of materials:

Sand, by bulk, 6, 4, 5, 4, 4, 5.

Hydraulic lime, by bulk, 1, 1, 1, 1, 1, 1.

Hydraulic cement, by bulk, 0, 0, 1-4, 1-4, 1-2, 1.

It may sometimes happen that too much water has been introduced into the preparation of the paste, by some cause or other. In that case I use a proportionate quantity of puzzalona, or of trass, or of any burnt clay properly prepared, but I regard all such addition as detrimental to the quality of the stone, and only use it in emergencies.

By employing none but white materials, a stone closely imitating white marble may be made, whilst, by the introduction in the paste of any coloring matters, oxides, carbonates, etc., or fragments of natural stones, any shade, variegations, or texture may be produced.

In some cases it may be found more convenient to measure the different materials, to introduce them all at once in the mill, and to subject the whole to an energetic trituration, and, when it is desirable to obtain the maximum of hardness, to return the paste a second, and even a third time to the mill, but in all cases the mass must be brought to the state of pasty powder, or short paste, which I designate as artificial-stone paste.

Agglomeration.

The artificial-stone paste, or pasty powder, described above, in order to become stone, has to be agglomerated in moulds, or, in other words, the grains of sand have to be brought in as near proximity, one to the other, as possible.

This I hold is impossible by any of the present modes of manufacturing artificial stones; for any pressure you may apply to one, both, or every side of a block of artificial-stone paste, will only agglomerate the parts close, or relatively close to the spot where the said pressure is exerted, leaving the middle of the block porous, spongy, and open. This, which is true of small blocks, as bricks, becomes still more apparent in large blocks, and in monolithic structures.

To obviate this difficulty, the following is the mode of agglomerating the artificial-stone paste which I employ:

We will suppose that it is desired to obtain a block of stone two feet long, one foot wide, and one foot thick. I procure a mould of the proper interior dimensions. This mould should be capable of sustaining heavy pressure, and of being taken apart at pleasure.

In this mould I introduce a certain quantity of artificial-stone paste, and with a rake I spread it to about one inch of thickness, more or less, according to the kind of work and char-

acter of the materials employed. Now, with a pounder, or a flat-end tool, heavy and hard, and by the application of repeated and systematic action on this stratum of material, I reduce its thickness to nearly one-half its height or thickness. When this stratum is perfectly packed in the mould, a new portion of material is introduced and packed in the same manner, so that by continuing to pour in the mould new portions of stone paste, and agglomerating said portions with the former strata, the whole mass has been packed and compressed in a most efficient manner, and when the stone has acquired the desired thickness in the mould, the said mould can be opened and the stone extracted.

In the case of masonry, the moulds may be made of a number of pieces, of the proper shape to confine the work, and be raised as the work progresses, so as to allow of the day's work to unite intimately with the work of the previous evening, whereby an endless stone may be obtained.

I do not deem it necessary to describe more at length this mode of establishing moulds, as they are well understood, in the construction of what are known as gravel structures, or concrete constructions, where a mortar, mixed with broken stones or gravel, is dumped into the moulds, arranged to determinate the thickness of the walls.

My invention, or the art of making endless stone by the agglomeration of sand, then consists in systematically regulating the amount of water employed in obtaining, by repeated or prolonged trituration, a viscous, plastic, pulverulent paste, or short pasty powder, and in agglomerating the same in moulds, by the systematic action of a pounder, or repeated blows of a hard and heavy tool, exerting its pounding effect upon successive strata of materials.

The difference of the result obtained by my mode of manipulation is manifest, when it is established that with the same proportions of lime, sand and cement I employ, any of the stones produced by other processes, after one year of exposure to the air, will hardly resist the crushing weight of ten or twelve kilogrammes to the square centimetre, whilst my specimens of stones, under the same circumstances, have resisted the enormous crushing weight of two hundred, three hundred, four hundred, and upwards of five hundred kilogrammes to the square centimetre, as shown by the report of M. Michelot, (*Ingénieur en Chef des Ponts et Chaussées,*) in his experiments made at the Conservatoire des Arts et Métiers of France, to establish the bearing-strength of my agglomerated artificial stones.

This extraordinary result is due to the fact, that in my system of manipulation, the lime employed is converted into a marble-like, or limestone-like carbonate, whilst in the other specimens of mortars, or artificial stones, it is present as a chalk-like carbonate of lime, having no cohesive strength.

What I claim, and desire to secure by letters patent, is—

1. The herein-described plastic, pulverulent artificial-stone paste, composed of sand, hydraulic lime, and, in some cases, hydraulic cement, prepared substantially in the manner and for the purpose set forth.

2. In the manufacture of artificial stones, or monolithic masonry, the herein-described mode of bringing the molecules of the mass in close proximity, one to the other, and obtaining a hard stone, by means and with the use of a heavy and hard pounder, exerting its action in a systematic manner upon successive layers of artificial-stone paste of the character and under the circumstances substantially as herein set forth.

3. As a new article of manufacture, the stones, or monolithic masonry, when made from the substances herein set forth, treated substantially in the manner specified.

FRANCOIS COIGNET.

Witnesses:

EMILE BARRAULT,
17 *Boulevard St. Martin,*

P. BONARD,
17 *Boulevard St. Martin.*

Patent No. 88,546.

Dated April 6, 1869.

To all whom it may concern:

Be it known that I, FRANCOIS COIGNET, of the city of Paris, in the department of the Seine, and empire of France, have invented certain Improvements in the Construction of Monolithic Structures; and I do hereby declare that the following is a full and exact description thereof, which will enable others skilled in the art to make and use the same.

This invention relates to the construction of buildings, dams, wharves, abutment-walls, bridges, etc., all of one piece of artificial stone, or of sections of the same joined together, the artificial stone being composed of sand, lime, and cement, prepared and agglomerated as described in my application for a patent for the same; and

The present invention consists in the introduction, into the moulds, of inside moulds, or cores, so as to obtain open spaces, cavities, flues, or, as it were, pipes, for the purpose of economizing the material employed for ventilating, warming, conveying water, gas, etc.

When I am building a dwelling-house, a church, a theatre, or any other kind of structure, of artificial stone, as the work progresses, the inside and outside parts of the walls are shaped by suitable sections of moulds, kept apart, and from spreading apart, by proper bolts, to give the thickness of said walls.

Now, to obtain any flues in the thickness of said walls, I place cores, of the proper shape and size, in the desired position for the same, and the artificial-stone paste, of appropriate character, is agglomerated all around said cores, and as the cores are removed, the wall is left perforated just in proportion as the cores are in number and size.

For the flues of chimneys, for the conveyance of smoke, a certain admixture of fire-clay may be introduced in the artificial stone-paste employed near the core. For the pipes or flues intended to convey water or gas, water-proof substances may be introduced; and for the ventilation and heating purposes, if the work is properly done, it is perfectly safe to dispense with the metallic casing ordinarily used for that purpose.

In building abutment walls, wharves, dock, dams, locks, etc., when, for the purpose of resistance, a great bulk of masonry is required, as, when finished, the whole structure will be but one stone—a monolith, in fact—I am able to obtain greater resistance and strength by making the structure of greater dimension, and, at the same time, diminishing the expense by making, by means of large cores, as above described, my walls hollow, full of perforations, niches, cells, flues, and hollows, which, by being filled with common earth pounded therein, go to make the weight required in the structure; and this system of building honey-combed monolithic structures, filled with common earth, will hold good as regards any works of art, where the total weight of the masonry is a guarantee of the strength thereof.

What I claim, and desire to secure by letters patent, is—

1. In monolithic buildings, made of agglomerated artificial stone-paste, the production of flues, pipes, or openings, for the purpose of heating, ventilating, conveying water, gas, or smoke, etc., by means and with the use of proper cores introduced in the thickness of the walls, and the agglomerating around said cores of a special composition of artificial stone-paste, in the manner and for the purpose herein set forth.

2. In monolithic structures, such as wharves, dams, abutment-walls, etc., making the walls hollow, or honey-combed, and filling the said hollows or cells with pounded earth, as herein set forth, for obtaining greater inertia-strength, or bulk of masonry, at a reduced expense.

FRANCOIS COIGNET. [L. S.]

Witness:

EMILE BARRAULT,
17 *Boulevard St. Martin.*

S. BONARD,
17 *Boulevard St. Martin.*

Patent No. 88,547.

Dated April 6, 1869.

To all whom it may concern:

Be it known that I, FRANCOIS COIGNET, of the city of Paris, in the department of the Seine, and empire of France, have invented certain Improvements in Artificial Stone, Monolithic Structures, and Artificial-Stone Articles; and I do hereby declare that the following is a full and exact description thereof.

This invention relates to the monolithic structures, or articles made of artificial-stone paste, agglomerated as described by me in my application for letters patent therefor; and

The present improvement consists in the introduction into the body of the structure, or of the stone article, of double-headed nails, double T-pieces, clamps, hoops, scraps of twisted, or irregular-shaped irons, for the purpose of strengthening the same, and giving it greater cohesive strength.

The irons to be thus introduced may be arranged in such a manner as to interlace each other, so that by the combination of this metallic skeleton, and of agglomerated artificial-stone paste, the thickness of the walls, or size of the articles, may be considerably reduced, and yet great strength be attained, Such, for example, would be the construction of a cylindrical web of small rod iron, or wire, upon and around which artificial-stone paste may be agglomerated, so as to obtain water-pipes capable of resisting an interior pressure, which is so necessary in such pipes.

Again, in the construction of troughs, or water-vats, angular-bent iron, or L-shaped pieces, may, with good effect, be introduced in the body of the materlal, to give greater strength to the angles, and prevent the trough from spreading asunder at those points.

The non-conductibility of the artificial stone made by my method, allows it to be used to good purpose, as a means of protecting and isolating telegraphic wires or conductors.

Claiming no novelty in the use of iron clamps, or frame-work of metal, in ordinary masonry, or brick-work for strengthening the same,

What I do claim, and desire to secure by letters patent of the United States, is—

1. The combination of agglomerated artificial-stcne paste with iron scraps of irregular shape, such as nails, double-headed nails, or bolts, rings, hooks, clamps, wire, etc., substantially in the manner and for the purpose set forth.

2. The introduction, in the body of artificial stones, or in the body of artificial-stone monolithic structures, made of agglomerated artificial-stone paste, of skeletons, or metallic frame-work, linked, or arranged so as to strengthen the same, substantially as specified.

3. The application of agglomerated artificial-stone paste to the protection and isolating of telegraphic wires.

FRANCOIS COIGNET. [L. S.]

Witnesses:

EMILE BARRAULT,
17 *Boulevard St. Martin.*

S. BONARD,
17 *Boulevard St. Martin.*

Patent No. 88,848.

Dated April 6, 1866.

To all whom it may concern:

Be it known that I, FRANCOIS COIGNET, of the city of Paris, in the department of the Seine, and empire of France, have invented certain new and useful Improvements in the Manufacture of Artificial Stones; and I do hereby declare that the following is a full and exact description thereof, which will enable any one skilled in the art to make and use the said invention.

In the ordinary way of employing hydraulic cements, a large quantity of water is used, so as to obtain a thin mortar, having the consistency of cream. This mortar is always used at once, and it is indicated by all good practical authors as a great blunder to let the cement-mortar set before you use it.

In my process, in order to obtain artificial stones of the greatest tenuity and hardness, I proceed thus:

I introduce the hydraulic cement, in a dry state, into a proper mill, and when it is in motion, I introduce just enough water to moisten the cement; and by prolonged and energetic trituration, I obtain a thick, plastic paste.

This plastic paste is now mixed with from two to three parts, in bulk, of good, sharp, fine sand, and the mixture is again returned to the mill, where it is again energetically triturated.

As it comes out of the mill, it is heaped up and left at rest for a few minutes, when it is mixed with a further quantity of good, sharp, clean sand, of proper coarseness, in the proportion of from two to four parts, according to the object for which it is to be employed, and it is again passed through the mill a third and even a fourth time, if necessary.

It comes out of the mill in the proper state of plastic powder, or short paste, and in that state is one of the best artificial-stone pastes that can be obtained, which, by proper agglomeration, will produce stones of the greatest hardness.

What I claim, and desire to secure by letters patent, is—

1. The use of hydraulic cement, ground with a relatively small quantity of water into a thick, plastic paste, for cementing sand in the manufacture of agglomerated artificial-stones.

2. The herein-described process of retarding the crystallization, or setting of hydraulic cements, by repeated and prolonged triturations, whereby the proper amount of sand may be incorporated therewith.

3. As a new article of manufacture, the artificial stones, or monolithic structures, made of hydraulic cement and sand, prepared and agglomerated substantially in the manner herein specified.

FRANCOIS COIGNET. [L. S.]

Witnesses:

EMILE BARRAULT,
17 *Boulevard St. Martin.*

S. BONARD,
17 *Boulevard St. Martin.*

Patent No. 88,549.

Dated, April 6, 1869.

To all whom it may concern:

Be it known that I, FRANCOIS COIGNET, of the city of Paris, in the department of the Seine, and empire of France, have invented certain Improvements in the Manufacture of Artificial Stones; and I do hereby declare that the following is a full and exact description thereof, which will enable others skilled in the art to make and use the same.

This invention relates to the manufacture of artificial stones, or monolithic structures, made by the agglomeration of hydraulic lime, hydraulic cement and sand, properly prepared in the state which I have established and specified, several times, as pulverulent paste, or plastic powder, and called artificial-stone paste; and

The present invention consists in the use of heat, or the application of heat, as hereafter specified, and for the purpose further explained

I have found, by repeated experiments, that when lime, hydraulic lime, sand, and, in some cases, hydraulic cements, are to be used for the confection of artificial stones, if these substances are previously heated to a proper degree; if hot water is employed for the preparation; if the mill in which the trituration of the substances is effected, is heated, either by the application of

artificial heat directly to the casing of the mill, by worms or otherwise, or if live steam is introduced into and through the substances undergoing trituration ; I have found, as I have remarked, that in that case the pulverulent paste which I obtain, possesses, to an extraordinary degree, the power of setting quickly and firmly, in short, of becoming quite hard as soon as it is agglomerated. This affords the greatest advantage for any piece of work that has to be exposed to frost a short time after it is made, and for all hydraulic works of art, and it allows, of course, the constructions to be carried on all through winter, which otherwise would be interrupted by cold weather.

In carrying my invention into practice, the sand, the lime, and the cement may be first heated, individually, by any convenient method, either by air, steam, or contact with heated surfaces.

The mill may be heated by the direct action of fire thereon, or by having a steam-jacket, or coiled pipe, and, in some cases, live steam may be injected into the mill during its action on the triturated substances, in any of these cases the result being the same, to bring up and maintain, at a proper temperature, the mass, so as to obtain a hot artificial-stone paste, ready for agglomeration in moulds, by the method I have already described elsewhere.

What I claim, and desire to secure by letters patent, is—

1. The application of heat in the preparation of artificial-stone paste, either to the materials employed, before being mixed, or to the mixture of the same, during the process of trituration, substantially in the manner and for the purpose set forth.

2. The manufacture of artificial stones, or monolithic structures, by means and with the use of hot agglomerated artificial-stone paste, substantially prepared as herein set forth.

FRANCOIS COIGNET. [L. S.]

Witnesses :

EMILE BARRAULT,
17 *Boulevard St. Martin.*

S. BONARD,
Boulevard St. Martin, 17.

Patent No. 98,033.

Dated December 21, 1869.

To all whom it may concern :

Be it known that I, FRANCOIS COIGNET, of Paris, France, have invented certain new and useful Improvements in Metal-Clad Artificial Stones ; and I do hereby declare that the following is a full and exact description thereof, reference being had to the accompanying drawings, forming part of this specification, in which—

Figure 1 represents a cross-section of one of my improved metal-clad artificial stones ;

Figure 2 represents a front view of the same ;

Figure 3 is a perspective view of the shield B ; and

Figure 4 represents, in section, a mould, and the process of manufacturing my improved stones.

This invention relates to that class of artificial stones which is manufactured by the agglomeration or agglutination of sand, or other similar substances, by a suitable cementing material ; and

My improvement consists in introducing into the moulds where such stones are cast, run or packed in, proper shields, corners, bands, angles, etc., of metal, and in providing said corners, shields, bands, or angles, with suitable clamps, hooks, bolts, etc., fastened to, or making part of the same, so that the soft material of the artificial stone will run, be cast, or be packed around

and against said hooks, bolts, or clamps, or dovetail projections, and against the inner side or face of the shield, angle, band, or corner-piece, in such manner, that when removed from the mould, I obtain a metal-clad artificial stone.

I will describe the manufacture of a curb-stone by my improved process, as any other stones used in the arts may readily be made by parties skilled in the art, after such description.

The metal border, or angle-iron piece, which I employ, is represented in fig. 3, where I have shown the clamp-pieces *c c c c*, which are fastened permanently to the angle-iron piece A. This may be made of iron, or of any other metal suitable for the purpose desired.

T is the mould in which the curb-stone is to be shaped, and it is represented in cross-section in fig 4.

The angle-piece A is placed in the mould T, in one of its lower corners or edges, and presenting the clamps *c c c* upward and inward.

The artificial stone is now made in the ordinary manner, taking care to have the material B well packed around and against the clamps *c c c*, etc., and this is best done by repeated layers, carefully agglomerated according to my several modes of operation already described in former patents.

When the mould is full, it is taken apart, and the stone, when hard, is turned over, and presents the appearance of fig. 2—a perfect stone, protected at its angle or most exposed part by a metallic shield.

I do not claim as new, the protecting of stone by metallic shields; but

What I do claim as my invention, and desire to secure by letters patent of the United States, is—

1. Protecting the exposed corners, sides, edges, or angles of artificial stones by means and with the use of metallic shields fastened thereto, in the process of manufacturing said stone, substantially in the manner herein set forth.

2. As a new article of manufacture, a metal-clad artificial stone, made substantially as herein described, for building-purposes, or other wants of the arts, industry or commerce.

In testimony whereof, I have signed my name to this specification, before two subscribing witnesses.

FRANCOIS COIGNET.

Witnesses:

EMILE BARRAULT,

AMART, 17 *Boul. St. Martin, Paris.*

Patent No. 98,034.

Dated December 21, 1869.

To all whom it may concern:

Be it known that I, FRANCOIS COIGNET, of the city of Paris, in the department of la Seine, France, have invented an Improved Mode of Employing Agglomerated Béton (concrete) "System Coignet;" and I do hereby declare that the following is a full and exact description thereof, which will enable any one skilled in the art to make and perform the same.

When we make a monolithic structure, or a block of artificial stone, by the system of agglomeration of sand, lime, and, in some cases, hydraulic cement, in the manner which I have described in my several patents, in pounding the artificial-stone paste, the pounder, presenting a smooth surface to the said paste, will, by its repeated action thereon, cause the same to be agglomerated into a stratum of a certain thickness, but presenting at its upper part a smooth surface, composed of an infinite number of small, smooth surfaces, the counterpart of the end of the pounder employed.

Now, as the setting of the lime and cement, the evaporation of the water, and the action of

the air, cause this smooth surface to harden promptly, if we spread upon this partly-dry and se smooth surface a new quantity of artificial-stone paste to form a second stratum, although, being in immediate contact with the former, this second stratum will not weld itself to the former one in an absolute manner, and this want of absolute welding, this solution of continuity between the two strata, may, in some cases, permit them to part, and thereby materially weaken the resistance of the mass, by presenting partings, beads, cleavages, or seams, throughout the mass of the béton.

To obviate this difficulty, I have found that it was desirable, and now I do recommend in future, that before introducing, on a stratum of artificial stone just agglomerated, a new quantity of artificial-stone paste to be agglomerated thereon, the smoothness of the existing stratum has to be destroyed, the molecules have to be raised, a roughness created by the application to the surface aforesaid of a suitable tool, such as a rake, a comb, toothed wheel, or barrel, or any equivalent instrument which will produce the desired effect, which is to obtain a rough surface. I now employ for that purpose a fragment of saw-blade, which, on being dragged along on the smooth surface, will tear it, scratch it, and roughen it, so that the new stratum will not find itself brought in contact with a smooth surface.

I would always recommend, when it is intended to apply a new stratum, to resort to this mode of roughening the last stratum before it is set or dry, as it will be found that the work is much better.

By this mode of operating, all the strata will be welded. They will strongly adhere one to the other, and there will be no fear of the masonry or block presenting the beads, seams, cleavages, or partings, of which I spoke above.

What I claim as my invention, and desire to secure by letters patent of the United States, is—

The herein-described mode of obtaining a masonry or block of artificial stone, of the character known as Coignet's agglomerate, without seams, beads, or partings, by means of the system of roughening of the surfaces of the strata, substantially as herein set forth.

In testimony whereof, I have signed my name to this specification, before two subscribing witnesses.

FRANCOIS COIGNET.

Witnesses:

EMILE BARRAULT,

AMART, 17 *Boul. St. Martin, Paris.*

Patent No. 98,035.

Dated December 21, 1869.

To all whom it may concern:

Be it known that I, FRANCOIS COIGNET, of the city of Paris, in the department of la Seine, and empire of France, have invented certain Improvement in Apparatus for the Manufacture of Agglomerates or Artificial Stone; and I do hereby declare that the following is a full and exact description of the same, having reference to the accompanying drawings, forming part of this specification, in which—

Figure 1 represents a sectional elevation of one of my improved malaxators, through the longitudinal axis of one of its twin helices;

Figure 2 represents a top view or plan of the same, having part of the top broken to show inside work; and

Figure 3 is a cross-section at *x x* of the helices and helix-case.

The preparation of the artificial-stone paste which I have described in my former patents, has caused me to modify greatly the apparatus generally employed in the manufacture of mortars, and to create or invent the following triturating-machine, which is characterized by the employ-

ment of twin and conjoint helices, parallel or convergent, turning in like or opposite directions, and being brought close enough, one to the other, so that their thread or blades work one in the other, and that they both exert their thrust in the same direction.

The operation of this apparatus is such, and the effect it produces upon my artificial stone paste is so defined, that I have called my machine a malaxator.

My malaxator brings up the material, and at the same time works it. It is provided with adjustable automatic arrangement for feeding itself with the substances or materials used in my preparation of artificial-stone paste; and, once set, will always deliver an identical product, at whatever speed it is run.

A is the frame of the machine, having at the upper end the cross-pieces B, upon which are mounted the gearings, and at the lower part, the cross-piece C, upon which are fixed the rests or steps, for the lower part of the helices to run in.

D are the cores of the helices, upon which are fastened the continuous or interrupted blades S S S, etc., forming the thread of the helix.

K are wagon-wheels, mounted upon the axle I, which enable the machine to be transported thereon, and which, when the machine is in use, serve to maintain the malaxator at its proper inclination, (about twenty-five degrees).

The brace J is used to steady the malaxator.

M N *m* N', gearings, of any kind, for giving motion to the helices, either by steam, horse, power, or hand-power.

q, conical sleeves or stoppers, adjustable upon the shafts D, for regulating the exodus of the artificial-stone paste, and by retarding the same, increase the pression and malaxation of the paste in the part Q' of the machine.

Q, body of the malaxator, corresponding in shape and size to the helices. (See drawings, fig. 3.)

P, receiving-chamber, where the materials enter the malaxator.

T, sand-hopper, with its adjustable register or gate *t*, and, when required, sifting-apparatus T',

q', sliding gate, to allow of the drainage of the machine.

S' S', feeding-screws, working in the lower part of the two hoppers R' R', the one for lime, the other for sand or any other material or substance to be introduced into the artificial-stone paste, and feeding the same to the chamber P.

$r\ r^1\ r^2\ r^3$, pulleys, for chains or belts *g*, for transmitting the movement to the feeding-screws S' S'.

$t^1\ t^2$, spur-wheel and pinion (changeable for others of different relative speed), for regulating the exact amount of the two substances in the hoppers R R, to be delivered, in so many turns of the helices, into the receiving-chamber P.

We have contemplated feeding, also, the water in an automatic manner, by the use of a suitable intermittent cock or reservoir-cock or valve, but so far, we prefer having a constant stream of water entering at Z, and an overflow at W for the same; and the sand being drowned or fully saturated in a given proportion, by varying the overflow W, gives us the proper amount of water for each turn of the helices.

H are movable wooden shafts, which are placed in proper straps in the machine, and serve to hitch or harness a horse to the same, when it has to be taken from one place to another, making it a perfect wagon.

Without precising the details of construction, which may be varied, the advantages we derive from the type of the apparatus I have invented, are the following:

First, the apparatus having the receiving-chamber P upon the ground, is fed easily, with little labor; and the part Q' or delivery elevated, allows of a wheelbarrow or basket being placed under to receive the artificial-stone paste. This inclination also causes a more powerful malaxation, by retarding the progress of the matter, owing to the specific gravity.

Second, the gearings are out of the way, away from sand, water, dust, etc.

Third, the helices, having their blades interlaid, their action upon the materials is of a quite different character than when said helices are not thus conjugated.

Fourth, the sand is gauged by a register. The lime and the hydraulic cement, the coloring matter, texture-giver, or any other material used, may be also fed automatically, and the machine once set by the inspector, the product is invariably the same, besides saving the labor of a hand whose trustworthiness was required to obtain good results. The continuous introduction, by small and regular quantities, of the different substances, and the constant amount of water supplied to the sand, place the materials in the best of circumstances for producing, by proper action of the helices, an excellent result, difficult to attain if the component ingredients had been thrown in by shovel or basketfuls at a time.

Having described, in full, my malaxator,

What I claim as my invention, and desire to secure by letters patent of the United States, is—

1. The inclined body or case P Q Q', in combination with the conjoint helices D S D S, substantially as and for the purpose set forth.

2. The regulating sand-hopper, with its gate *t*, or equivalent device, in combination with the helices D S D S and case P Q Q'.

3. The use of one or more screws S', with hopper R, and of definite rotated spur-wheels and pinions t^1 t^2, in combination with the helices D S D S, substantially as specified, and to the end of securing automatic feed to the malaxator.

4. The water pipe Z and variable overflow W, or their equivalent, to obtain the effect specified upon the sand in the malaxator.

5. The conical adjustable sleeves *q q*, in combination with the piece Q' and conjoint helices D S D S.

6. The combination of the wheels K K, body P Q Q', and shafts H H, in the manner and to the end set forth.

In testimony whereof, I have signed my name to this specification, before two subscribing witnesses.

FRANCOIS COIGNET.

Witnesses:

EMILE BARRAULT, 17 *Boulevard St. Martin.*

AMART, 41 *Rue Merlay.*

Patent No. 99,062.

Dated January 25, 1870.

To all whom it may concern:

Be it known that I, FRANCOIS COIGNET, of the city of Paris, in the department of la Seine, and empire of France, have invented certain Improvements in Artificial Stones and Monolithic Structures; and I do hereby declare that the following is a full and exact description thereof, which will enable others skilled in the art to make and use the same.

The use of fat-lime concretes for the erection of buildings, bridges, dams, etc., is very limited, because, by all the known processes of manipulation of the said fat lime, the setting of such concretes is generally so slow as to require weeks, months, and, in some cases, years, before they acquire the desired strength for resisting the influences of the elements.

It is true, that of late it was hoped that by substituting hydraulic cements for fat lime, a concrete could be obtained which would answer for building above ground, but the results, in practice, have not answered these expectations.

These hydraulic-cement concretes, if made by the ordinary methods, do not resist the changes of temperature, cracking in the air, and becoming spongy. They are also more expensive, and their manipulation requires a strict and constant watching.

The object of my present invention is to point out a sure and reliable mode of obtaining, always in a practical manner, with ordinary or fat lime and sand, or sand and gravel, a good concrete, which may be used for all purposes of construction, either as artificial stone, or for monolithic structures, as well in elevation as for underground works.

This result cannot be obtained without bringing all the molecules of the concrete in closer proximity than they can be brought by the ordinary processes now employed; and I have found that the only practical mode of obtaining a good result, was by the following process:

The proportion of fat lime and sand I employ is to be varied according to the object in view, and of the quality of the lime or sand which is at hand; and in this particular, it is much the same as in the confection of ordinary concretes, but the amount of water is of a capital and all-important consequence; it has to be just enough for properly slaking the lime, and furnishing the due amount of dampness for the crystallizing of the lime, and as this varies with the specimens of lime employed, nothing but practice can point out the exact amount of water to be used.

The materials—sand, lime and water—are now to be triturated energetically in a mill, which will act by compression, friction, and agitation, and the material, to be ready for use, must present the peculiar appearance of pasty powder, so characteristic in my process of manipulation.

This pasty powder is now agglomerated in moulds, or in spaces where it is required to be used, by successive layers, systematically pounded all over by the repeated action of a flat-ended rammer, and no one layer is laid over the previous one until said layer or shatterer has been perfectly packed and agglomerated.

This mode of packing the granulated concrete paste in successive thin layers, and of applying thereto, all over the surface thereof, the pounding action of a rammer, so as to exert on every particle of material, and through the whole mass, a heavy and resistless pressure, is what I call my process of agglomerating, and it is in a great measure this process to which is due the hardness of my stones.

By this combination of processes I obtain a stone or masonry-setting quickly, and presenting, after due exposure to the influence of the elements, the marble-like character so desirable in artificial stones, which cannot be obtained with fat lime and sand by any other known process of manipulation.

When for some purpose I desire to obtain a quicker setting of my stones or masonry, I employ a small quantity of good hydraulic cement, in combination with the lime; but in many cases I only use the fat lime.

What I claim as my invention, and desire to secure by letters patent of the United States, is—

The process, or combination of the several physico-chemico mechanical means, above described, of employing fat lime, or common lime, in artificial stones or monolithic structures, substantially in the manner and for the purpose set forth.

FRANCOIS COIGNET.

Witnesses:

GUIDO BARRAULT,

AUNEIL.

Improvement in Pavement Blocks. Application filed June 20, 1873.

Patent No. 148,818.

Dated March 24, 1874.

Be it known that I, JOHN C. GOODRIDGE, Jr., of the city of Brooklyn, county of Kings and State of New York, have invented a new and useful Improvement in an Article of Manufacture to be known as Tree-Gratings, of which the following is a specification:

The object of my invention is to make a pavement adapted to be used around trees, that will allow air and moisture to get to their roots, prevent the ground near them from getting packed, and at the same time allow the space around them to be used as a walk or way.

To make this, I first prepare an artificial paste, which may be of any of the artificial stone or concrete mixtures, but preferably of that material known as béton-coignet, and manufactured under patents granted Francis Coignet, of Paris, France, and numbered, respectively, 88,545, 88,546, 88,547, 88,548, 88,549, 98,035, 98,033, 98,034, and 99,062.

The artificial stone paste or concrete, in a plastic state, is rammed into moulds, in the bottom of which are inserted pieces of wood, or other material, of the size and shape desired in the apertures of the grating. The mould is then removed, and, after a sufficient time is allowed for the material to thoroughly set, it is then placed in pieces of the required shape around the tree. The pavement can also be moulded in the place where it is to be used, the moulds and pieces being held in proper positions to preserve the open space by a wooden or metallic frame-work, which, when the material has been placed around them, can be removed, leaving the walk perforated. These perforations can be of any shape or size. A diameter of one to two inches is found to give the best results. Grooves may also be cut in the upper and lower sides of the pavement, allowing more easy escape for the water, and facilitate cutting away a portion of the stone as the tree enlarges.

This grating can be laid above the ground, supported at proper intervals, when it is desirable.

While more especially designed for trees, it can be used in water-closets, at boat-landings, and in all places where it is desirable to have a pavement dry and clean at all times, and not absorbing moisture,

It is also applicable as a combined grating and ballast for boats, fitting close to the bottom, leaving a dry flooring, and saving the necessity of other ballast; being cheap, it can be thrown overboard when required, and in the event of a boat capsizing will discharge itself.

Having thus described my invention, what I claim is—

A perforated pavement of artificial stone or concrete, as described, and adapted to the purposes set forth.

JOHN C. GOODRIDGE, JR.

In presence of—

H. H. HALL,
HENRY CASE.